FOOD PREPARATION STUDIES

CHILD

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Food preparation.

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7. Proteins 8. batters
9. doughs 10. candy 11 sugars
12. frozen mixtures
13. food preservation
14 Jelly making.

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BY

ALICE M. CHILD
Late Associate Professor of Home Economics
University of Minnesota

KATHRYN B. NILES
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PREFACE

The goal of food study should be to develop the ability to plan meals and to select and prepare food, so that optimum meals for the family may result with a reasonable expenditure of time and effort, and the wise use of money.

In the development of food preparation courses for students at the college level there has been a very definite effort on the part of most teachers to depart from the traditional rule-of-thumb methods and to explain cookery processes on a scientific basis.

In this volume a minimum amount of general information dealing with cookery processes and the production and composition of foods is included. Emphasis is placed upon those significant facts or principles[1] resulting from investigations in such basic sciences as chemistry and bacteriology, and from experimental work in foods laboratories which indicate desirable practices in food selection, storage, and preparation.

It is to be expected that the students will study some of the suggested readings listed in each chapter to supplement the material included in this manual. Many of the questions which introduce the chapters cannot be answered unless such reading is done.

The average student has neither the time nor the opportunity to investigate the reports of the original researches which set forth the scientific facts and principles which govern food selection and cookery processes. Moreover, many such reports are so technical that undergraduate students are unable to interpret them.

The material which comprises this manual has been gathered from many sources, including reports on experiments published in periodicals and bulletins and the authors' own experimental work. In teaching undergraduate and graduate students over a period of many years, the authors have become convinced that real values occur from the organization of content adopted for this manual, even though it represents a departure from that of the typical textbook.

In order to make the material readily accessible, the subject matter is organized in a purely logical way into chapters dealing with cookery processes and special groupings of foods. However, no instructor should assume that she should arbitrarily follow this sequence in her teaching. If it is desired to organize the course around food combinations, this may easily be done. If it is desired to emphasize the experimental viewpoint, laboratory work may be so planned that students cook various foods in different ways, compare the results, and determine the principles that explain them.

Experience has shown that students must master an extensive vocabulary of technical terms before they can understand present-day literature dealing with food selection and preparation. A list of technical terms is therefore included in each chapter as a means of helping students recognize those which are really important.

[1] A principle in food preparation is considered to be an underlying fact governing a method of procedure.

An appendix includes a glossary of important terms, score cards for judging the quality of foods, and other material helpful in food work.

The authors wish to express appreciation to Mrs. Lillian Butler, Dr. Cornelia Kennedy, Mr. Charles Rogers, and Miss Mary Satorius for helpful criticisms of the material in the manual. Special thanks are due Miss Clara M. Brown for her suggestions regarding organization of content and the permission to use certain material she has developed, and to Mrs. Rosalind Simon for her assistance in the revision of the manual. They also wish to express their appreciation for the permission granted by the American Home Economics Association to reproduce material from the publications of that organization.

A.M.C.
K.B.N.

University of Minnesota
October, 1937

FOOD PREPARATION STUDIES

INTRODUCTION

If students possess a knowledge of nutrition and the scientific facts and principles which explain why certain practices are accepted and others are not, they are more likely to prepare appetizing meals which will furnish adequate nutrients at a reasonable cost, and less likely to continue practices which have been shown to be unsatisfactory.

It is not assumed that one term or even one year of instruction in foods will result in excellent cooks. Manipulation, skill, the recognition of desirable standards, and management ability are achieved only through much practice. However, one term of instruction in this field may accomplish a great deal in a relatively short time, if optimum use is made of various techniques which have been developed. For example, if students, as well as instructor, have clearly in mind the goals toward which they are striving, more rapid progress is to be expected than if objectives are less specific. The list of objectives given below are those set for the elementary food preparation course at the University of Minnesota in 1937–1938. They have evolved over a period of years from a continuing study of what such a course should offer, and have been modified materially as a result of recent experimentation with teaching methods.

Objectives for Food Preparation at the University of Minnesota[1]

The following objectives indicate the direction of effort, with the full realization that many of them will not be reached by the end of the first course in foods.

I. *Attitudes.*
   1. To develop an interest in the preparation of food.
   2. To desire to repeat the preparation of products until a satisfactory standard has been reached.
   3. To feel responsible for keeping the laboratory in order.

II. *Habits.* To develop habits of:
   1. Personal cleanliness.
   2. Orderliness and cleanliness in food preparation and laboratory work.
   3. Measuring accurately and being economical of food supplies.
   4. Planning work so as to save steps and time.
   5. Working at reasonable speed.
   6. Using as few dishes in the preparation of food as is compatible with efficiency.
   7. Evaluating own products and management ability.

III. *Knowledge.*
   1. To gain the vocabulary of technical and scientific terms needed to understand the

[1] Clara M. Brown assisted in the development of these objectives.

subject matter discussed in lectures and references and found in advertisements and newspaper and magazine articles on food.

2. To understand the scientific principles that explain cookery processes.
3. To understand basic proportions for common recipes and the bases upon which substitutions can be made.
4. To know how to plan time schedules.
5. To know how to make out market lists.

IV. *Skills.*

1. To be able to prepare common foods so as to obtain palatable and attractive products, and at the same time retain their nutritive values.
2. To be able to select and use the methods of preparation and temperatures which will produce desirable products.
3. To be able to evaluate common food products in terms of such characteristics as flavor, color, and texture.
4. To be able to use and care for the ordinary utensils and pieces of kitchen equipment.
5. To be able to choose suitable dishes for food to be served in and to set a cover properly.
6. To be able to prepare a simple meal and have everything ready to serve at the same time.

If certain aspects of the course are analyzed so that only relevant and important materials are stressed, students are more likely to master essentials than if such an analysis has not been made. The laboratory skills given below were listed as important by a large group of high school and college teachers of home economics, home makers, and women in business. The starred (*) skills were listed by all these groups as of fundamental importance; the other skills were considered to be very important by many people, but agreement as to their importance was not so general as for the others.

If devices are made available whereby students can evaluate their own achievement and check their progress toward the goals set up, one may anticipate greater progress than if such evaluation is not made. The use of such score cards as those illustrated on pages 137–144 has shown their value in enabling students to gain a clear conception of what satisfactory food standards are, and to accelerate their attainment of desirable standards in the food they prepare. These score cards are very quickly used so that time can *always* be given for scoring.

Important Laboratory Skills Involved in Food Preparation[1]

*1. Measuring accurately.
*2. Following a recipe.
3. Knowing how to use basic proportions in preparing a few simple products.
4. Making ordinary substitutions in a recipe, as:
   a. Bread flour for pastry flour or whole wheat flour.
   b. Sour milk for sweet milk.
   c. 100% fats for 80% fats.
5. Heating product without causing deterioration:
   *a. Milk or thickened liquid so it will not scorch.
   *b. Fat so as to avoid smoking.
*6. Thickening liquid to desired consistency without product curdling or getting lumpy.

[1] Compiled by Clara M. Brown.

7. Knowing when to use a given process, as:
   - *a. Boil *vs.* simmer.
   - *b. Cook covered *vs.* uncovered.
   - *c. Start cooking in hot *vs.* cold water, or hot *vs.* cold oven.
   - *d. Use little *vs.* much water in cooking vegetables, cereals, etc.
   - *e. Use one method *vs.* another in combining ingredients, as in cakes.
   - *f. Beat eggs slightly *vs.* until stiff.
   - *g. Bake or roast *vs.* broil *vs.* pan-broil *vs.* braise *vs.* steam.
   - h. Cook in double boiler *vs.* over direct flame.
   - i. Cook in pressure cooker.
   - j. Cook in slightly acid *vs.* slightly alkali medium.
   - k. Cook whole *vs.* in small pieces.
   - l. Add sugar before *vs.* after product is cooked.
   - m. Add salt before *vs.* after product is cooked.
8. Being able to prepare fruits, vegetables, meats, etc., by:
   - a. Chopping.
   - b. Grating.
   - *c. Paring.
   - *d. Peeling.
   - *e. Scraping.
   - f. Sectioning.
   - *g. Washing.
   - *h. Wiping or cleaning.
9. Mixing ingredients properly by:
   - *a. Beating.
   - *b. Creaming.
   - *c. Cutting.
   - *d. Cutting and folding.
   - *e. Kneading.
   - *f. Melting.
   - *g. Rolling.
   - *h. Stirring.
10. Combining ingredients at proper time and in proper way, as:
    - *a. Dry and liquid ingredients.
    - *b. Fat and dry ingredients.
    - *c. Milk and acid.
    - *d. Egg and hot liquid.
    - e. Vegetables or other solid food and gelatin mixture in molded salad.
    - f. White sauce and vegetables for soups or creamed dishes.
11. Being able to use processes commonly employed in preparing and cooking food, as:
    - *a. Baking.
    - *b. Boiling.
    - *c. Braising.
    - *d. Broiling.
    - e. Cooking by means of pressure cooker.
    - f. Frying in deep fat.
    - g. Hydrating.
    - *h. Making coffee by drip method.
    - *i. Making coffee by percolating.
    - j. Marinating.
    - k. Making emulsions.
    - l. Pan frying.
    - m. Roasting.
    - n. Scalloping.
    - o. Searing.
    - p. Simmering.
    - p. Steaming.
    - r. Steeping.
    - s. Whipping.
12. Adding flavoring at proper time to get palatable product.
*13. Adding proper amount of seasoning to get palatable product.
*14. Regulating temperature of flame or cooking surface or oven.
*15. Maintaining low temperature for milk, cheese, and egg products during cooking.
*16. Knowing approximately how long it takes to prepare and cook different products.
17. Knowing when products are sufficiently cooked:
    - *a. Baked products—biscuit, bread, cake, muffins, rolls, pastry.

*b. Beverages.
*c. Cereals.
*d. Cheese dishes.
*e. Custards and other egg dishes.
*f. Meats.
*g. Puddings.
*h. Frostings.
*i. Jelly.
*j. Starchy vegetables.
*k. Succulent vegetables.

18. Preparing salads with appropriate dressings, so as to get attractive product which will have.
*a. Crisp lettuce (vegetables and fruits, if used).
*b. No excess water or juice.
*c. Food cut into pieces of proper size.
*d. Salad and dressing properly combined.
*e. Pleasing arrangement on plate or serving dish.

19. Handling products properly when cooking is finished:
*a. Cooling or keeping warm.
*b. Draining.
*c. Drying.
d. Allowing steam to escape.

20. Handling utensils properly when cooking is finished:
a. Drying.
b. Scraping *vs.* not scraping.
c. Soaking in cold *vs.* hot water.
d. Washing.

Chapter I

COOKERY PROCESSES

A knowledge of the various cookery processes and of the scientific principles which underlie them is desirable because it enables one to select for each food the process or processes which are likely to produce the most attractive, palatable, and nutritive product.

The following are the commonly used cooking processes:[1]

With moist heat:

Boiling is cooking in water or other liquid at a temperature at which bubbles rise continually to the surface and break.

Braising is browning in a small amount of fat and then cooking at a simmering temperature in a small amount of water.

Simmering is cooking in liquid at a temperature of about 185°F., at which bubbles form slowly and break below the surface.

Steaming is cooking in steam with or without pressure.

Stewing is cooking or boiling in a small quantity of liquid. When applied to meat, simmering temperature is used.

With dry heat:

Baking is cooking in the oven, on metals, stones, or in ashes and under coals. When applied to meat it is called *roasting*.

Broiling is cooking by radiant heat from a flame, electric element, or open fire.

Pan-broiling is cooking in a hot, uncovered frying pan without the addition of fat.

With fat:

Frying is cooking in fat, applied especially: (1) to cooking in a small amount of fat, also called *sautéing*; (2) to cooking in a deep layer of fat, called also *deep-fat frying*.

[1] From *Meat Cookery Definitions*. Cooperative Meat Investigations. (Mimeographed.)

Table 1 lists the smoking temperatures of some of the common cooking fats. The smoking temperatures of fats and oils vary. The smoking temperature is lowered when (1) the fat has become acid owing to the presence of free fatty acids, (2) when foreign particles are present, and (3) when a larger surface is exposed.

TABLE 1

SMOKING TEMPERATURES OF SOME ORDINARY COOKING FATS*

Kind of Fat	Smoking Temperature	
	Degrees C.	Degrees F.
1. Butter fat	208	406
2. Cottonseed oil (Wesson)	233	451
3. Crisco	231	448
4. Lard (bulk)	194	381
5. Lard (leaf)	221	430
6. Lard (leaf heated 5 hours)	207	405
7. Lard (much used)	190	374
8. Olive oil	175	347
9. Snowdrift	232	450
Bacon fat†	145	293
Suet†	117	243

* All except the last two fats were studied by K. BLUNT and C. M. FEENEY, and reported in *The Smoking Temperature of Edible Fats*, J. Home Econ. **7**: 535, 1915. They used a 10-centimeter evaporating dish in determining smoking temperatures.

† WILLIAMS, A. and GRAY, C. Univ. of Ill. Bull. **47**: 4 and 17, 1917. Smoking tests were made on one cup of fat in a small saucepan 6 inches in diameter.

Table 2 indicates the frying temperatures now generally accepted for different foods.

TABLE 2

TEMPERATURES FOR DEEP-FAT FRYING*

Type of Product	Temperature of Fat		Time Required to Brown 1-inch Cube of Bread in the Hot Fat
	Degrees F.	Degrees C.	Seconds
Dry, uncooked foods Croquettes containing raw foods Doughnuts Fritters	350 to 365	177 to 185	60
Cooked foods Cheese balls Croquettes containing cooked foods Fish Oysters	365 to 382	185 to 195	40
Wet, cold, uncooked foods French-fried potatoes Potato balls	382 to 390	195 to 200	20

* *Terminology Used in Food Preparation.* A. H. E. A.

SOME APPROVED PRACTICES IN VARIOUS COOKERY PROCESSES

1. After water has begun to boil the heat should be reduced, with only sufficient heat applied to maintain the boiling temperature.
2. Food cooks as quickly in gently boiling water as in rapidly boiling water.
3. Use a candy thermometer to test the doneness (degree of concentration of sugar solutions) of candies and frostings.
4. Cooking time and methods must be adjusted in high altitudes.
5. Cook such foods as eggs, milk, and cheese in a double boiler.
6. Do not boil tea or coffee or overcook fruits.
7. Fruit cooks more rapidly in a syrup than in water.
8. Use a shallow uncovered pan and boiling temperature when quick evaporation is desired.
9. Use a deep covered pan and a temperature below boiling when a minimum amount of evaporation is desired.
10. Be particularly careful not to get burned by steam, since steam burns more severely than boiling water.

11. Use hot-pack rather than cold-pack method in canning.
12. Insert metal skewers into a large roast in order to reduce the time for roasting.
13. Use fats with a high-smoking temperature for frying.
14. Dip croquettes in egg before frying.
15. Use a small-diameter utensil for deep-fat frying.
16. Use a pressure cooker to cook foods rapidly or to can non-acid vegetables which require a high temperature for sterilization.
17. Large roasts, cakes, or baked dishes require a proportionately longer time to cook than do those of small size.
18. Remember that baked products rise after they are in the oven.
19. Do not heat fat to a higher temperature than is necessary to cook a particular food.
20. Allow croquettes to dry on the surface before frying in deep fat.
21. Do not use the same fat too many times for frying.
22. Do not cook foods at too low a temperature.
23. Dry potatoes with a cloth before making French fries or potato chips.
24. Clarify often fats used for deep-fat frying.
25. Use a thermometer in deep-fat frying.
26. Drain fried foods on brown paper to get rid of excess fat.
27. If flavor of butter is desired in a fried product, combine fat which has a high-smoking temperature with butter or brush cooked product with melted butter before serving.

Add other approved practices.

List each of the approved practices in various cookery processes in the blank space opposite the fact or principle which affords scientific basis for the practice.

Scientific Facts and Principles	Approved Practices
1. Each gram molecular weight of a non-ionizable substance will raise the boiling point of a liter of water ½°C.	Fruit cooks more rapidly in a syrup than in water.

Scientific Facts and Principles	Approved Practices
2. Volatile substances are driven off by boiling.	
3. As steam condenses it gives up latent heat of vaporization to the object upon which it condenses.	
4. The temperature of boiling water cannot be raised above 212°F. (100°C.) unless some soluble substance is added, or pressure applied.	
5. The rate of evaporation when liquids are heated is increased when there is an increase in temperature or an increase in amount of surface exposed, or when vapor is removed from the surface.	
6. The boiling point of a solution is raised as the concentration becomes greater.	
7. The boiling point of a liquid is reduced 1°F. for every 500 feet increase in altitude, or 1°C. for every 900 feet.	Cooking time and methods must be adjusted in high altitudes.

Scientific Facts and Principles	Approved Practices
8. With every increase of 5 pounds of pressure, the temperature of steam increases approximately 10°F.	
9. The smoking temperature of fat is lowered after prolonged exposure to heat.	
10. The higher the temperature to which a fat is heated, the greater the decomposition.	
11. Fats smoke at a lower temperature when a foreign material is present.	Clarify often fats used for deep-fat frying.
12. A coating of egg on a product reduces the amount of fat absorbed.	
13. Foods cooked in fat absorb more fat at low than at high temperatures.	

Scientific Facts and Principles	Approved Practices
14. The longer a food is in contact with the fat, the more fat it absorbs.	
15. The greater the amount of surface exposed, the more quickly fats reach the smoking temperature.	
16. The temperature of the liquid in the double boiler is approximately 185°F. (simmering temperature).	
17. Water added to hot fat causes a bubbling because of the steam formed.	
18. Gases expand when heated.	
19. Metals are good conductors of heat.	

Scientific Facts and Principles	Approved Practices
20. Foods are poor conductors of heat.	

Chapter II

COOKING UTENSILS[1]

Today, cooking utensils are made from a wide variety of materials. It is desirable to understand the characteristics of the different materials in order to know how to use a utensil, how to care for it, and how to clean it. In the following pages are listed the materials commonly used for cooking utensils, together with descriptions of their composition, their characteristics, and the methods one should employ in caring for each one.

Aluminum

Aluminum is an alloy which is either poured into a mold to form the utensil (cast aluminum) or drawn out into a sheet which is pressed into the desired shape. The drawn and pressed utensils are much lighter in weight and tend to dent and buckle but have practically the same thermal efficiency. Aluminum is stained by alkalis, and is easily scratched by coarse abrasives or metal scourers. Wash aluminum utensils with warm water and a mild soap. If stained, the discoloration may be removed by cooking in the utensil an acid food such as tomatoes or rhubarb, or by heating vinegar in it. Use only very fine abrasives if food adheres to the surface and must be scoured off.

Brass

Brass is an alloy of copper and zinc. It is not recommended for cooking utensils because it tarnishes in moist air and forms poisonous substances which are soluble. If used it must be kept brightly scoured. It may be cleaned with whiting and a dilute acid such as vinegar or lemon juice and polished with rottenstone or special metal polish. Stronger acids such as oxalic or hydrochloric may be used but they must be handled with great care.

Chromium Plate

Iron, steel, or copper utensils are plated with a thin layer of chromium. This produces a shiny, attractive surface that does not tarnish. Clean with warm water and soap. Scouring is likely to remove the plating.

Copper

Copper utensils have a high heat conductivity but the metal is relatively soft. Like brass it tarnishes easily and poisonous compounds are formed. It is not satisfactory for cooking utensils unless plated with some other metal. It may be cleaned like brass or with kerosene.

Earthenware

Earthenware is made of baked clay which has been sprayed with a glaze and refired. It

[1] Jeanette Lee assisted in selecting material for this chapter.

absorbs heat readily, is attractive, and is easily cleaned. It can be used for baking, and the food is often served from the dish in which it was baked. Its chief disadvantage is that it tends to break easily if subjected to sudden changes in temperature. Use warm water and soap and a mild abrasive if necessary.

Enamelware

The cheaper grades of enamelware are made by coating an iron or steel base with a thin layer of molten glass. In the better grades several layers of the glaze are applied. Enamelware absorbs heat readily but the cheaper grades chip easily. It is injured by the use of rough abrasives, and sudden changes of temperature cause it to crack. Use a wooden rather than a metal spoon for stirring in an enamel container. If the utensil is greasy, boil it in hot soda water and wash in soapsuds.

Glass

Glass utensils absorb heat readily, are attractive, easily cleaned, and very durable unless they are subjected to sudden changes in temperature. Wash with warm water and soap, using a mild abrasive if necessary.

Iron

Cast-iron utensils absorb heat readily and heat evenly. They are durable and especially desirable for frying pans; but they are heavy, and tend to rust unless dried carefully after use. To prevent rusting, rub surface of new utensil with grease or oil and heat for a long time at a low temperature. If the utensil rusts, clean with kerosene and wash thoroughly with hot soapy water.

Stainless Steel

Stainless steel is an alloy in which nickel and chromium are used. It does not tarnish, is heavy and very durable, and does not dent. It reflects heat. It requires little care and will not crack or scratch.

Tin

Thin sheets of iron or steel are coated with tin. This produces a product which is attractive in appearance, with a shiny surface. It is light in weight and heats quickly, especially after it has been in use for some time. Tin buckles and dents easily. It does not rust when in constant use until the tin coating begins to wear off. If the utensil is greasy, place in hot soda solution and then wash in hot soapsuds. A fine abrasive may be used if necessary.

Some Approved Practices in the Selection, Care, and Use of Various Utensils

1. Medium- or light-weight utensils are as satisfactory as heavy utensils from the standpoint of thermal efficiency.
2. Use flat-bottomed utensils when cooking on an electric range.
3. Light-weight aluminum and tin utensils are not desirable because they tend to buckle.
4. The specific conductivity of a metal is of negligible importance in selecting a cooking utensil.
5. Coarse abrasives may be used on iron and stainless-steel utensils, but should not be used on aluminum.
6. Water containing sulphides or carbonates discolors aluminum.

7. Cook acid foods (tomatoes or rhubarb) or boil a vinegar solution in darkened aluminum utensils to brighten them.
8. Avoid sudden temperature changes for glass, earthenware, or enamel utensils.
9. The inside of copper cooking utensils should be plated with another metal.

Add other approved practices.

List each of the approved practices in the selection, care, and use of utensils in the blank space opposite the fact or principle which affords a scientific basis for the practice.

Scientific Principles	Applications
1. The degree of absorption of radiant heat by a utensil has a greater effect on its thermal efficiency than does its specific heat or specific conductivity.	
2. Radiant heat is absorbed more readily by a dull, dark, or rough surface than by a shiny, polished, or smooth surface.	
3. The difference in temperature between the utensil and the surrounding air determines the amount of heating accomplished by convection—regardless of material.	

Scientific Principles	Applications
4. Variation in the speed of heating of oven utensils depends upon: a. Oven temperature. b. Relative amounts of convection and radiation. c. Relative reflecting and absorbing powers of dish materials.	
5. Air and liquids are poor conductors of heat. Layers of air and liquid on the exterior and interior of vessels hinder conduction of heat.	Use flat-bottomed utensils to minimize the air film between utensils and heating unit.
6. When a heated utensil is surrounded by an insulating material, heat is conserved and cooking below boiling point is continued.	
7. The weight or thickness of a utensil has no significance for its thermal efficiency.	Medium- or light-weight utensils are as satisfactory from the standpoint of thermal efficiency as heavy utensils.
8. The solubility of a metal is determined by the degree of electro-affinity of the metal as compared to hydrogen. Tin and iron dissolve slowly in acids.	
9. Aluminum is darkened and discolored by the carbonates of the alkaline metals and of the alkaline-earth metals and by sulphides.	Water containing carbonates or sulphides will discolor aluminum.

Scientific Principles	Applications
10. Dilute acid will dissolve the dark coating on aluminum utensils.	
11. Soluble poisonous carbonates or oxides are formed on copper in the presence of moist air.	The inside of copper cooking utensils should be plated with another metal.
12. Materials expand when heated and contract when cooled.	Avoid sudden temperature changes for glass, earthenware, or enamel utensils.
13. Aluminum is a relatively soft metal.	Avoid using coarse abrasives or metal scourers on aluminum utensils.
14. Iron and stainless steel are very hard materials.	

Chapter III

BEVERAGES

A beverage is a drink which may or may not have food value, depending upon the kind of beverage and what is added in serving it.

Questions on Beverage Preparation

1. What are the soluble substances in tea and coffee which may be obtained in the beverage prepared from each?
2. Which contains more tannin, a green or black tea infusion?
3. Why is there a difference in the color and flavor of tea infusion from green and black tea?
4. What causes iced tea to become cloudy at times?
5. Why does lemon make tea lighter in color?
6. Which method of preparation gives maximum caffeol and minimum tannin?
7. What are the common mistakes in brewing coffee by steeping? Percolating?
8. What are two effects of using egg in steeped or "boiled" coffee?
9. Why does the addition of cold water settle coffee?
10. What granulation of coffee would you suggest for use with each type of equipment?
11. How could you make satisfactory coffee without a coffee pot?
12. Why is cocoa mixed with the sugar before any liquid is added?
13. Why is cornstarch suggested in the preparation of cocoa and not in chocolate?
14. What is the skin on the top of heated milk?
15. Under what conditions would you recommend the use of a saucepan for the preparation of cocoa and chocolate? The double boiler?
16. What causes cocoa to scorch?

General Information on Different Beverages

Coffee

Coffee is the berry of the coffee tree. Most of the coffee used in this country comes either from Central or from South America, and takes the name of the locality in which it is grown. The most important blends of coffee are Java, Mocha, Colombia, Bogota, Guatemala, Salvador, and Maracaibo.

The green berries are *roasted* until they are brown and have developed a characteristic aroma. After roasting, coffee contains caffein, caffeol, tannin, caramelized carbohydrates, and carbon dioxide. *Caffein* is an alkaloid which is responsible for the stimulating effect of coffee. *Caffeol* is an essential oil which produces the aroma and some of the flavor. *Tannin* is an astringent which is found in many plants in addition to tea and coffee; it is responsible for the bitter taste which develops when coffee is improperly brewed. *Carbohydrates*, which have been caramelized during the roasting process, give coffee its brown color and add to its

flavor. *Carbon dioxide* (CO_2) is produced when the coffee is roasted and forms a film on the coffee berry.

Coffee is sold in many different forms. The berry may be ground to different degrees for *steeping*, *percolating*, *filtering*, or *dripping*. It may also undergo certain special treatments. It may have the caffein either partially or wholly removed by a chemical process; it is then sold as "decaffeinized coffee." It may be made into a concentrated brew and evaporated until it is in the form of a condensed liquid, or until it is in the form of minute brown crystals; then it is sold as a soluble or "instant" coffee.

Coffee substitutes are for the most part made of crushed cereals which have been roasted, and to which have been added molasses and caramelized sugar to give flavor and color.

Tea

Tea is the tender leaves of the tea shrub, grown chiefly in the Orient. It may be cured with varying degrees of fermentation. Green tea is not fermented. Oolong tea is semi-fermented, and black tea is fermented.

Tea contains theine, theophylline, tannin, and a volatile essential oil. *Theine* is an alkaloid similar to the caffein in coffee. *Theophylline* is similar to the theobromine in chocolate.

The degree of fermentation determines the proportion of tannin in tea, but has no effect upon the theine which is approximately 3%. In green tea there may be as much as 10% of tannin, but in black tea this has been reduced to 5%.

Tea is labeled according to grade, and grade is determined by the position of the leaf on the branch, as is shown below:

Location of Leaf	*Green Tea*	*Black Tea*
End bud when very small	Gunpowder	Flowery Pekoe
End bud when large and second leaf	Imperial	Orange Pekoe
Third-size leaves	Young Hyson	Pekoe
Largest leaves	Hyson	Soochong

Cocoa and Chocolate

Both cocoa and chocolate are obtained from the bean or seed of the cacao tree. After the beans are dried and roasted they are broken and freed from the shell and germ. They are then called *cocoa nibs*. These are ground and pressed into a solid or plastic mass which is known as *plain* (or bitter) *chocolate*. If sugar and cocoa butter are added to the plain chocolate, it is called sweet chocolate; if milk also is added, it is called *milk chocolate*. If about half of the fat is extracted from plain chocolate, and the resulting product is ground to a fine reddish powder, it is known as *cocoa*. Sometimes an alkaline solution of potassium carbonate, ammonium bicarbonate, sodium carbonate, or sodium bicarbonate is added to cocoa, producing what is known as *Dutch process cocoa*, which is less soluble than cocoa before this treatment and has a different flavor and browner color.

Cocoa and chocolate contain theobromine and cocoa tannin. *Theobromine* is an alkaloid like the caffein in coffee and the theine in tea and is a stimulant. *Cocoa-tannin* is similar to the tannin in tea and coffee and produces the red-brown color.

The percentage composition of chocolate and cocoa differs because of the fat extraction. The usual composition is shown in Table 3.

TABLE 3

COMPOSITION OF CHOCOLATE AND COCOA[1]

Constituents	Percentage Chocolate	Composition Cocoa
Protein	12.9	21.6
Fat	48.7	28.9
Carbohydrate	30.3	37.7
Ash	2.2	7.2
Water	5.9	4.6

Standards for Beverages

Coffee should be clear with no suspended particles. It should have a stimulating aroma and a fresh and mellow rather than a bitter taste. If it is made with 1 tablespoon of coffee per cup, it should be an amber color; if made with 2 tablespoons of coffee per cup, it should be a medium brown. After cream is added the color should be a rich tan.

Tea should be clear with no solid particles. It should have a delicate aroma and a distinctive flavor which will vary with the blend. It should not be bitter. Black tea should be an amber color; green tea should be yellow-green; and Oolong should be a light amber.

Cocoa and *chocolate* should be a rich brown color, of uniform consistency like thin cream, with little or no sediment and with no scum on the surface. There should be a well-developed and definite flavor of chocolate, with no bitter taste.

All beverages should be served very hot unless they are iced.

TECHNICAL VOCABULARY USED IN BEVERAGES

acidity
adsorption
alkali
alkaline carbonate
alkaloid
aroma
astringent
basic
brew
carbon dioxide
caffein
caffetannic acid
calcium carbonate
caramelized
carbohydrates
chicory
decaffeinized
density
dilution
Dutch process
emulsify
essential oils
evaporate
fat
fermentation
filtration
gel
granulation

[1] Sherman, H. *Food Products*. Revised Edition, p. 508.

grind
gunpowder
hydration
Hyson
infusion
isomeric
Java
lactose
melting point
mineral
Mocha
Pekoe
percolating
precipitate
Salvador
Santos
solubility
Soochong
stearin
steeping
suspension
tannin
theine
theobromine
theophylline
viscosity
volatile oils

Some Approved Practices in the Purchasing and Preparation of Beverages

1. Purchase freshly roasted and freshly ground coffee.
2. Use glass, porcelain, or vitrified-surface utensils rather than metal ones for making tea and coffee.
3. Clean coffee pot with soda solution.
4. Purchase coffee in small amount and store in air-tight containers after opening packages.
5. Brew tea and coffee as short a time as possible to obtain the desired strength.
6. Keep temperature below the boiling point when preparing tea or coffee.
7. Use water for tea and coffee as soon as it begins to boil.
8. Use soft water in making tea and coffee when possible.
9. Separate cocoa with cold liquid or sugar before adding hot liquid, when preparing cocoa.
10. Melt chocolate over hot water.
11. Add cornstarch to cocoa to give it more body and retard settling.
12. Cook cocoa with water until the starch is thoroughly cooked before adding it to the scalded milk.
13. Keep chocolate in a cool place and in an air-tight container free from moisture.
14. Scald milk in a double boiler or watch carefully if heating it over direct flame.
15. Stir or beat cocoa or chocolate to break up skin and produce a froth, which lessens skin formation.
16. Keep chocolate and cocoa covered if they are allowed to stand before serving.
17. Add hot liquid to melted chocolate to prevent hardening of the fat.

Add other approved practices.

List each of the approved practices in the purchasing and preparation of beverages in the blank space opposite the fact or principle which affords a scientific basis for the practice.

Scientific Facts and Principles	Approved Practices
1. The essential oils are volatile, and their rate of loss is proportional to the temperature applied and the length of time the product is heated.	
2. Fermentation of tea leaves decreases the solubility of tannin.	
3. Tannin dissolves more readily in an alkaline medium than in one which is acid or neutral.	
4. Caffein and theine are soluble in water at any temperature; tannin dissolves more rapidly in boiling water than in water at a lower temperature.	Brew tea and coffee as short a time as possible.
5. The film of carbon dioxide which coats the coffee bean is lost when the coffee is ground. This permits the escape of some of the essential oils which give coffee its flavor and aroma.	Purchase freshly roasted and freshly ground coffee.

Scientific Facts and Principles	Approved Practices
6. Acid bleaches the brown color which is characteristic of tannin.	
7. Contact with the air intensifies the color of tannin.	
8. Tea and coffee react chemically with metals.	
9. Standing in contact with the air or prolonged boiling drives some of the free oxygen out of water and gives it a flat taste.	
10. When hot water comes in contact with starch before the grains have been separated by some mechanical means, the starch swells suddenly and the outside of the mass is cooked while the inside remains in the form of raw starch, causing the mixture to become lumpy.	When preparing cocoa separate cocoa with cold liquid or sugar before adding to hot liquid.
11. Starch is almost insoluble in cold water and forms a colloidal solution with hot water.	

Scientific Facts and Principles	Approved Practices
12. Starch has a gel-forming quality.	
13. Milk when heated without agitation or exposed to the air develops a skin which consists chiefly of calcium caseinate.	
14. Chocolate scorches very easily because of its sugar and fat content.	
15. The higher the fat content of milk, the lower the temperature at which the skin forms when milk is heated and exposed to the air.	
16. The melting point of cocoa butter is low.	
17. Lactose caramelizes easily.	

Suggested Readings

Beverages

Justin, M. M., Rust, L. P., Vail, G. E. *Foods*, pp. 96–107; 388–391.
Macleod, A. L., Nason, E. H. *Chemistry and Cookery*, Second Edition, pp. 410–418.
Stanley, L., Cline, J. A. *Foods, Their Selection and Preparation*, pp. 414–434.
Sherman, H. C. *Food Products*, Third Edition, pp. 527–535.

Chapter IV

FRUITS, VEGETABLES, AND CEREALS

Fruits, vegetables, and cereals are important in the diet mainly for cellulose, minerals, and vitamins, and are useful in giving variety.

Suggested Questions on Fruit, Vegetable, and Cereal Cookery

1. Why do fruits cooked in a syrup become more firm in texture?
2. Why do some blue plums become red when cooked?
3. Why do fruits become more transparent when cooked in a sugar syrup?
4. What happens to sucrose when it is cooked with fruits?
5. Why do mechanical refrigerators have hydrators for keeping vegetables?
6. When should vegetables be salted?
7. Should cucumbers be soaked in salt water before serving? Explain.
8. What factors enter into the palatability of vegetables?
9. What causes the loss of desirable texture in succulent vegetables when improperly cooked?
10. How can the flavor of vegetables be preserved in cooking?
11. How does the acidity of the medium of cooking affect the color of green vegetables? of white? of yellow? of red?
12. Explain why long cooking of vegetables decreases their nutritive value.
13. Why do vegetables of the cabbage family have particularly poor flavor when overcooked?
14. Why does cabbage retain its green color when cooked in milk?
15. How can the liquid in which vegetables are cooked be utilized?
16. What effect does cooking have upon cereals?
17. What are the factors affecting the amount of water used with the different types of cereals?
18. Upon what ingredient is the proportion of salt based? Why?
19. What are significant differences in rice cooked by boiling and by steaming? Account for this.
20. How long should cereals be stirred?
21. What causes a skin to form sometimes on top of cooked cereals? How may this skin be prevented?

General Information about Fruits, Vegetables, and Cereals

Fruits

For most uses fruit should be at the best stage of ripeness. Underripe and overripe fruit have an inferior flavor; overripe fruit may have begun to decompose.

Important changes occur during the ripening of fruit: (1) the fruit increases in size; (2) the green color tends to become yellow, red, or purple; (3) the tissues lose their firmness and become softer; (4) flavor and aroma develop; and (5) much of the starch is changed to sugar.

Fresh fruits usually contain only approximately 20% of solid materials: carbohydrates, fat, protein, and minerals. Organic acids and esters are also present and give fruit its flavor.

Citric acid is found in oranges, grapefruit, and lemons; malic acid is found in apples; benzoic acid in cranberries, strawberries, and prunes; oxalic acid in pineapples; and tartaric acid in grapes.

Dried fruits are prepared by removing all but approximately 20% of the moisture. Seven pounds of fresh apples are used to obtain one pound of dried apples. To keep the fruit, such as apples, from becoming dark, sulphur dioxide is used in the dehydration. Instead of this being harmful, as was once thought, it appears to have a protective influence on the vitamin C content. To replace the water lost in the dehydration process it is necessary to soak the fruit prior to cooking.

Frozen fruit, now obtainable on the market, is frozen so quickly that the cell walls of the fruit are not ruptured. Frozen fruits should be used as soon as they are defrosted; otherwise they deteriorate rapidly. If they are to be cooked they require only about half the cooking time that fresh fruits do. The freezing of fruit makes it possible to ship ripe fruit to distant markets. This fruit has a superior flavor to that which has been picked in a green state for shipping. Apparently freezing does not affect the food value of fruit.

Vegetables

Vegetables may be classified according to structure, composition, flavor, and color. Classified according to *structure* (the portion of the plant which is edible), vegetables are:

Bulbs—garlic, leeks, onions.
Flowers—broccoli, cauliflower.
Fruits—cucumbers, eggplant, melons, peppers, tomatoes.
Leaves—chard, cress, dandelions, endive, lettuce, spinach.
Roots—beets, carrots, parsnips, radishes, turnips.
Seeds and seed pods—green or wax beans, peas, corn.
Tubers—artichokes, Irish potatoes.

The composition of vegetables is determined by the kind of vegetable, the variety, the age, soil, growing conditions, and storage. Classified according to composition, vegetables are thought of as either starchy or succulent.

Carbohydrates are found in vegetables in the form of starch, sucrose, dextrose, levulose, cellulose, and hemicellulose; proteins in legumes take the form of globulins; fats are found in small amounts, usually in the seeds; all vitamins, and especially A, C, and B_2 (or G), occur in vegetables. Many vegetables are excellent sources of minerals, especially iron, phosphorus, and calcium. Aluminum, chlorine, copper, fluorine, magnesium, manganese, potassium, silicon, sodium, sulphur, and zinc may also be present.

Vegetables may be *mild flavored*, as potatoes, celery, and carrots, or they may be *strong flavored*, as old cabbage, cauliflower, and onions. They likewise vary in color; they may be *green*, as lettuce, spinach, and green beans; they may be *red*, as beets and red cabbage; they may be *yellow*, as carrots, squash, and sweet potatoes; or they may be *white*, as Irish potatoes, parsnips, and some varieties of onions.

Standards for Cooked Vegetables

Vegetables are most attractive and palatable when they are so cooked that the original color is retained, they are tender but still hold their shape, there is no excess water, they are well seasoned, and the natural flavor is retained or intensified.

Cereals

Cereals are the seeds of grasses; they contain, in a very compact form, the materials needed for the development of the new plants. They represent the cheapest source of energy and must furnish a considerable portion of the diet when money for food is limited. They are valuable chiefly for their carbohydrate content (up to 75%) although they also contain protein (10 to 12%), fat (up to 8%), minerals, and vitamins.

The carbohydrates found in cereals are mostly starch and cellulose. The proteins are of the incomplete type—chiefly in the form of albumins, glutelins, globulins, and the prolamines which are characteristic of cereals. The fats are in the form of phosphoric-organic compounds. The minerals most commonly found are calcium and phosphorus, but frequently other minerals are present, depending upon the content of the soil in which the cereal is grown. Cereals represent the most valuable source of vitamin B and vitamin B_2 (or G); they contain little vitamin A and almost no vitamin C or D. When grain is sprouting, however, some vitamin C is present.

All cereals have a definite *structure*. The outside layer is *bran*, which is chiefly cellulose and minerals. Next to that is the *aleurone* layer, valuable for protein and minerals. The *endosperm* comprises the bulk of the seed and is largely starch. The *germ* which represents only a small portion of the bulk contains fat and is especially rich in minerals and vitamins.

Market Forms

Cereals may be purchased uncooked, partially cooked, or ready to serve. The uncooked cereals may be sold in the *whole form*, as rice or cracked wheat, or in the *granular* form, as corn meal and farina. The partially cooked cereals, such as rolled oats, are usually sold in flakes. An increasing number of ready-to-serve cereals are on the market—flaked, puffed, or shredded.

Cookery

Cereals are cooked to soften the cellulose and develop flavor. The length of the cooking period will depend upon whether the starch is raw, dextrinated, or hydrolyzed; how much cellulose is present; and whether the grain is whole, cracked, or granulated.

The amount of water necessary for the cooking of cereals depends upon a number of factors: the *consistency desired*—corn meal mush that is to be fried should be thicker than if it is to be served as porridge; the *composition* of the cereal—the greater the amount of cellulose, the longer the cooking period; the amount of *exposed surface*—the greater the proportion of exposed surface, the larger the proportion of water; the *method of cooking*—when there is little opportunity for evaporation, as in the fireless cooker, less water is needed than when cereal is cooked in a double boiler, and less when it is cooked in a double boiler than in a saucepan. Time, however, may be a counterbalancing factor, for if cereal is cooked for a

long time more water is required. Also, the long cooking process is often carried on in utensils which permit a minimum of evaporation.

Standards for Cooked Cereals

The cooked cereal should have no lumps; it should tend to retain its shape in the dish when it is hot. It should be soft, but the shape of the particles should be retained. The natural flavor of the cereal should be developed, and it should be well seasoned.

Information about Different Constituents in Fruits, Vegetables, and Cereals

Carbohydrates

Carbohydrates appear in three distinct forms, starch, sugars, and cellulose, each of which has many variations. Each of the general classes will be discussed separately because their characteristics vary greatly. Because starch is most commonly found in the powdered form, as in flour, a discussion of starch is included in the chapter dealing with salad dressings and white sauces.

All fruits, vegetables, and cereals contain carbohydrates, but the form and the amount vary greatly. For example, such leafy vegetables as lettuce and celery have a very low starch content and a relatively high cellulose content. Beets and other root vegetables have a high percentage of both starch and cellulose. Also, it must be noted, the relative percentage of starch, sugar, and cellulose changes with the maturing and the ripening of the plant.

From the standpoint of chemical structure, carbohydrates may be classified as:

1. *Monosaccharides* ($C_6H_{12}O_6$) such as glucose, fructose, and galactose.
2. *Disaccharides* ($C_{12}H_{22}O_{11}$) such as sucrose, lactose, and maltose.
3. *Polysaccharides* ($C_6H_{10}O_5$) such as starch, cellulose, and gums.

Certain forms of carbohydrates hydrolyze readily and break down into simpler substances. For example, starch changes into dextrin and water under the influence of enzymes, acids, or heat. Further decomposition results in maltose and water, then in dextrose, and the end-products are carbon dioxide and alcohol.

The complexities of the chemical structure of carbohydrates may be confusing. However, the reasons for the different methods of cooking carbohydrate foods become clear when one learns certain fundamental facts about the different forms and their behavior under specified conditions.

Starch

For discussion of starch see Ch. V.

Sugars

For discussion of sugars see Ch. VIII.

Cellulose

Cellulose is found in the woody portions of plants and is present in varying amounts in fruits, vegetables, and cereals. It is the most important source of roughage and is necessary for proper digestion.

In young and tender fruits and vegetables cellulose is in the form of *hemicellulose*, which is readily hydrolyzed to form sugar. *Pectocellulose* is usually present in fruits, but in amounts that vary greatly with the fruit and its stage of maturity; it is hydrolyzed by moist heat. *Adipocellulose* forms the surface tissue of leafy vegetables and is affected by dry but not by moist heat. *Lignocellulose* is found in vegetables that are fully matured, especially if they are dry. It is affected by neither dry nor moist heat. Whether or not cellulose is affected by cooking and the digestive juices depends, therefore, upon the particular form of cellulose.

Pigments

The color substance of fruits and vegetables may be divided into four classes:

Chlorophyll is the green coloring material of plants. It is generally accompanied by two yellow pigments, carotene and xanthophyll.

Carotinoids is the term given to orange and yellow pigments. These include carotene and xanthophyll. Carotene is found in squash, carrots, and sweet potatoes. *Lycopin* is an isomer of carotene, and is more red in color than carotene. It is found in tomatoes, red pepper, and watermelon.

Anthocyanins include the pigments varying from red through violet to blue. They occur most frequently in fruits and flowers, causing brilliant colors in these, but are also found in large quantities in such plants as the red cabbage, beets, and radishes.

Flavones are pigments which are almost colorless in low concentration.

Minerals

Minerals are very soluble, and care must be taken in the preparation of fruits and vegetables, which are the most important sources, so that the percentage lost is kept as low as possible. Losses are not so important in fruit cookery as in vegetable cookery because the juice in which fruits are cooked is usually retained whereas that from vegetables is often discarded. The value of minerals is not affected by cooking.

The most important vegetable sources of the following minerals are:

Calcium: snap beans, cabbage, carrots, cauliflower, celery, endive.
Phosphorus: Brussels sprouts, cauliflower, corn, spinach, legumes, potatoes.
Iron: legumes, spinach, broccoli, kale.
Manganese: spinach, beets, string beans, cauliflower, celery, carrots, potatoes.

Flavors

Many plants contain oily substances, essential oils, in their blossoms and fruits which give the characteristic flavor and fragrance. Esters, aldehydes, and other organic compounds give flavor to fruits.

In strong-flavored vegetables the flavor is due to a compound sinigrin (a glucoside) which hydrolyzes to glucose and other compounds of which hydrogen sulphide (H_2S) and allyl isocyanate ($CH_2 = CHCH_2CNO$) are significant. Sinigrin is found in such vegetables as cabbage, cauliflower, and Brussels sprouts.

Vitamins

Vitamins are substances essential to nutrition and normal growth of man; they exist in natural foods in minute quantities. The six vitamins recognized as the most important at present are designated by the letters A, B_1, C, D, E, and B_2 (or G). They may be classified according to their solubility, and are thus designated as fat-soluble or water-soluble.

The *fat-soluble* vitamins are A, D, and E. Vitamin A and vitamin D are *both* present in certain animal products; each is present in certain other foodstuffs.

TABLE 4

RELIABLE SOURCES OF FAT-SOLUBLE VITAMINS

Sources of Vitamins A and D	Additional Sources of		Sources of Vitamin E
	Vitamin A	Vitamin D	
Butter* Cream* Cod-liver oil Egg yolk Glandular organs (especially liver) Milk, whole*	Cheese Oranges Tomatoes Vegetables, green or yellow	Oysters Salmon Foods irradiated with ultra-violet light	Grains, whole (especially in germ) Liver Meats Vegetables, green vegetable oils

* Concentration of vitamins varies greatly in different samples.

The *water-soluble* vitamins are C, B_1, and B_2 (or G). Vitamin B_1 (thiamin) is the most widely distributed vitamin. Vitamin B_2 (riboflavin) is closely associated with B_1 and is found in the same foods although in different concentrations.

TABLE 5

RELIABLE SOURCES OF WATER-SOLUBLE VITAMINS

Sources of Vitamin C	Sources of Vitamins B_1 and B_2 (or G)
Fruits, citrus Grains (germinated and sprouted) Tomatoes Vegetables, green	Cereals, whole (especially in the germ) Egg yolk Fruits, citrus Glandular tissues and internal organs such as liver, kidney, heart, and brain Milk and cream Vegetables Yeast

Technical Vocabulary Used in a Study of Fruits, Vegetables, and Cereals

acid
adsorption
alcohol
alkali
anthocyanin
arrowroot
au gratin
benzoic acid
blanch
carbohydrates
carotinoids
cellulose
chlorophyll
citric acid
dehydrate
dextrin
dextrose
disaccharides
enzyme
escalloped
esters
ethylene gas
ferric salts
flavones
fructose
gel
glucose
gluten
granular
hemicellulose
hydrolysis
invert sugar
iron salts
lactose
legumes
lycopin
malic acid
maltose
minerals
monosaccharides
organic acids
osmosis
oxalates
oxidation
pectic acid
pectin
pectocellulose
polysaccharides
protopectin
sinigrin
soluble salts
starch
succulent
sucrose
tannin
vitamins

Some Approved Practices in the Preparation of Fruits, Vegetables, and Cereals

1. Cook fruit in syrup rather than in water to retain its shape and not become mushy.
2. Cover fruit when cooking, if possible.
3. When making pickles from citron, watermelon rind, or other fruit which has a large amount of cellulose, cook to partial tenderness before adding sugar and vinegar.
4. Cook dried fruits in the water in which they have been soaked.
5. To retain the natural flavor of fruit, cook as short a time as possible.
6. Cook vegetables containing vitamin D by any household process and it is not affected.
7. Vegetables can be stored any length of time without loss of vitamin B_2 (or G).
8. Use vegetables as soon as possible after cooking, especially green vegetables.
9. Do not soak vegetables before cooking.
10. Do not add soda to water in which vegetables are cooked.
11. Cook vegetables by baking and by steaming when possible.
12. Use smallest possible amount of water in cooking all mild-flavored vegetables.
13. Cook vegetables only until tender.
14. Save water in which vegetables have been cooked, or from canned vegetables, and use in soups, gravies, or as liquid for white sauce.

15. Start cooking vegetables in boiling water and bring water again to boiling point as soon as possible.
16. Cook vegetables whole, or in large rather than in small pieces, when boiling them.
17. Do not cook cabbage, cauliflower, or any strong-flavored vegetables in the pressure cooker.
18. Never add acid to water in which green vegetables are cooked.
19. Cook green vegetables uncovered, especially during the first few minutes of cooking.
20. Cook carrots by any method and they will not lose their color.
21. Cook tomatoes by any method and their color is not changed.
22. Do not cook rice or potatoes in iron kettles or in enamel pans that are chipped.
23. Add finely ground cereals to water very carefully, or mix with a little cold water before adding to boiling water.

Add other approved practices.

List each of the approved practices in the preparation of fruits, vegetables, and cereals in the blank space opposite the fact or principle which affords a scientific basis for the practice.

Scientific Facts and Principles	Approved Practices
	Starch
1. Starch has a great capacity for absorbing water (hydration); the absorption is rapid and complete in hot water.	
	Cellulose
2. Cellulose tends to take the form of lignocellulose as the vegetable ages and dries.	

Scientific Facts and Principles	Approved Practices
3. Hemicellulose is readily hydrolyzed by moist heat.	
4. Cellulose is softened by alkalis.	
5. Cellulose fibers may be broken by mechanical means and rendered more palatable.	
6. Cooking in moist heat tends to soften the cellulose.	
7. Cellulose is toughened by the addition of acids.	
8. Cellulose is toughened by the addition of sugar.	

Scientific Facts and Principles	Approved Practices
	Minerals
9. Minerals are very soluble.	Cook dried fruits in water in which they have been soaked. Cook vegetables by baking and steaming when possible.
10. Minerals are not affected by high temperatures.	
11. The larger the amount of water, the greater the loss of minerals in solution.	
12. The longer the period of cooking the greater the loss of minerals in solution.	
	Pigments
13. Heat decomposes chlorophyll and changes the green color to olive green or brown.	
14. High temperatures produce rapid decomposition of chlorophyll.	Do not cook green vegetables in a pressure cooker.

Scientific Facts and Principles	Approved Practices
15. Chlorophyll is only slightly soluble in water.	
16. In the presence of alkalis, chlorophyll is hydrolyzed and forms salts which are intensely green.	
17. In the presence of acids, chlorophyll decomposes and forms compounds which vary in color from yellow to olive brown.	
18. The cell structure of plants is broken down during cooking and plant acids are formed. Plant acids are volatile.	
19. Reactions causing color changes in green vegetables are irreversible.	
20. Carotinoids are insoluble in water at any temperature, and are not affected by heat or acids.	

Scientific Facts and Principles	Approved Practices
21. Lycopin is an isomer of carotene and has similar characteristics.	
22. Anthocyanins are very soluble in water.	
23. Reactions causing color changes in anthocyanins are reversible.	
24. The color of anthocyanins is intensified in an acid medium; in an alkali medium the color becomes bluish green.	
25. Flavones are very soluble in water.	
26. Flavones are colorless in an acid medium.	

Scientific Facts and Principles	Approved Practices
27. Flavones are yellow in an alkaline medium.	
28. Flavones unite with iron salts to form dark-colored compounds.	
	Flavor
29. The constituents which give flavor to fruits and vegetables are unstable compounds sensitive to changes in acidity and heat.	
30. Sinigrin decomposes rapidly at high temperature.	
31. Esters are easily decomposed by heat.	
32. Sugar offsets an acid flavor.	

Scientific Facts and Principles	Approved Practices
33. Salt gives flavor and helps to bring out other flavors.	
	Vitamin A
34. Vitamin A or its pro-vitamin is rapidly destroyed at high temperatures in the presence of oxygen or an oxidizing factor.	
35. Vitamin A is heat resistant under normal conditions.	
36. Vitamin A is stable to acids and alkalis.	
37. Vitamin A is ordinarily insoluble in hot water.	
38. Vitamin A is destroyed by hydrogenation.	

Scientific Facts and Principles	Approved Practices
	Vitamin D
39. Vitamin D is stable to ordinary cooking processes and at autoclave temperatures.	Cook vegetables containing vitamin D by any household process and it is not affected.
40. Vitamin D can be oxidized, but not so readily as vitamin A.	
	Vitamin E
41. Vitamin E is extremely stable to high temperatures, ultra-violet ray, atmospheric oxygen, strong acids, alkalis, and hydration.	
42. Vitamin E is insoluble in water.	
43. Vitamin E is stable to hydrogenation.	
44. Vitamin E is not affected by oxidation.	

Scientific Facts and Principles	Approved Practices
	Vitamin B_1
45. Vitamin B_1 is stable to heat under ordinary conditions of cooking and canning.	
46. Vitamin B_1 is more stable on heating in the dry state than in solution.	
47. Vitamin B_1 is sensitive to alkali; the action is increased by heat.	Do not add soda to water in which vegetables are cooked.
	Vitamin B_2 (or G)
48. Vitamin B_2 (or G) is stable to heat.	
49. Vitamin B_2 (or G) is not easily oxidized.	
50. Vitamin B_2 (or G) is sensitive to light.	

Scientific Facts and Principles	Approved Practices
51. Vitamin B_2 (or G) is destroyed in an alkaline medium.	
52. Vitamin B_2 (or G) is soluble in water.	
	Vitamin C
53. Vitamin C is stable to acids.	
54. Vitamin C is very sensitive to alkali.	
55. Vitamin C is very soluble in water.	
56. Vitamin C is readily destroyed in the presence of oxygen. Long periods at low temperature are more destructive than short periods at high temperature.	

Scientific Facts and Principles	Approved Practices
57. Vitamin C is preserved in foods that are cooked or dried in the absence of oxygen or in a vacuum.	

Suggested Readings

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Cereals

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Chapter V

SALAD DRESSINGS AND WHITE SAUCES

Salad dressings furnish a satisfactory method for including fat in the day's meals. They contribute to the flavor, texture, color, and variety of such foods as mild fruits, vegetables, and meats.

Since, in the preparation of white sauces, cream soups, and gravies, one must consider both fats and starch, these are included in this chapter, and facts and principles applicable to the cookery of fats and starch are given.

Suggested Questions on Salad Dressings, White Sauces, and Fats

1. What is an emulsion? An emulsifying agent? What are the general properties of an emulsifying agent?
2. What kind of an emulsion is French dressing? Mayonnaise dressing? Explain.
3. Name the fats that may be used in salad dressings.
4. What substances aid in producing a permanent emulsion in salad dressing?
5. Why is the acid added to the egg before emulsification in mayonnaise?
6. What limits the amount of oil that may be added in making mayonnaise?
7. What are some causes for the breaking of an emulsion?
8. Why should mayonnaise be kept tightly covered?
9. Under what conditions should salad dressings be kept in the home?
10. What type of salad dressing would be best to use in a frozen salad? Explain.
11. Why will dry starch added to hot water form lumps?
12. Why is it hard to digest lumpy starch products?
13. What chemical change takes place when starch comes in contact with acid or heat?
14. Why is the thickening power of starch decreased when it is browned?
15. Why should starch mixtures be covered during cooking and cooling?
16. What are the physical and chemical differences between fats and oils?
17. What is hydrogenation? Give examples of hydrogenated fats.
18. Upon what does the melting point of a fat depend?

Salad Dressings

Classification of Salad Dressings

Uncooked salad dressings.
- Temporary emulsions: French dressing.
- Semi-permanent emulsions: French dressing with gelatin or other partial stabilizer.
- Permanent emulsion: mayonnaise (emulsion of fat in water and acid).

Cooked salad dressings.
- Custard basis.
- White sauce basis.
- Combination of white sauce and custard.

Combination of cooked and uncooked dressings.

White sauce with mayonnaise: modified mayonnaise.

Both mayonnaise and French dressing depend upon the principles of emulsions for their preparation. An *emulsion* is a suspension of one liquid in another with which it is immiscible. An *emulsifying agent* is a substance which acts as a stabilizer. *Mayonnaise dressing* is an emulsion of oil in acid and water stabilized by a colloid. *French dressing* is a temporary emulsion of oil in acid and water without a stabilizer.

Standards for Salad Dressings

Mayonnaise dressing should be smooth and shiny, with no oil visible. It should be thick enough to hold its shape if it is to be thinned with cream, and thinner if it is to be used as prepared. It should be well seasoned.

French dressing should have a consistency varying from that of thin to thick cream, and it should be well seasoned.

Cooked salad dressing should be the consistency of thick white sauce if it is to be thinned with cream. If it is to be used as prepared it should be thinner. It should be tart and well seasoned, and should have no starch flavor.

White Sauces

The proportion of flour to liquid places white sauces in a definite series which is given in Table 6.

TABLE 6

Proportions for Different Types of White Sauces

Type	Liquid	Flour	Fat	Seasoning
Thin	1 c.	1 t. to 1 tb.	1 tb.	¼ t.
Medium	1 c.	1½ tb. to 2 tb.	2 tb.	¼ t.
Thick	1 c.	4 tb. to 6 tb.	0 to 4 tb.	¼ t. or more

Table 7 gives the proportions of basic material to add when using white sauce as a base.

TABLE 7

Uses of Different Types of White Sauces and Proportions of Solid Ingredients

Food	Consistency of White Sauce	Amount of Solid Ingredients to 1 Cup of White Sauce
Cream soup	Thin or very thin	½ c. to 1 c.
Creamed meats or vegetables	Thin or medium	2 c. to 4 c.
Escalloped dishes	Medium	2 c. to 4 c.
Croquettes	Thick	2 c. to 4 c.

Fats and Oils

General Information about Fats and Oils

Fats and oils are composed of the elements hydrogen, oxygen, and carbon combined in such a way as to form a compound of glycerol and fatty acids. A *solid fat* has a melting point above room temperature (e.g., lard). An *oil* has a melting point below room temperature (e.g., corn or cottonseed oil).

Hydrogenation of Fats

Hydrogenation is the process by which liquid fats are changed into solid fats by heating with hydrogen in the presence of a catalytic agent. The carbon of the unsaturated fatty acids takes on hydrogen, thus:

Hydrogenation has certain definite effects upon fat. Hydrogenated fats are flavorless or at least very bland in flavor; they are lighter in color, smoother in consistency, and more easily creamed than unhydrogenated fats. Hydrogenation of liquid fats raises the melting point and improves the keeping quality.

Flavor of Fat

The flavor of fresh fat is due to the free fatty acids and unknown substances rather than to the glycerides present, because the glycerides are both tasteless and odorless. When fats become rancid as a result of oxidation and hydrolysis in the presence of moisture and heat, the flavor changes markedly. Natural fats contain a fat-splitting enzyme which acts in the presence of moisture and hastens hydrolysis. After hydrogenation this enzyme is no longer present or active.

Types of Edible Fat

There are many edible fats, some of which are liquid and some solid at room temperature. The following are those commonly used.

Liquid fats.

Cream is that portion of milk, consisting largely of globules of milk fat, which rises to the top when milk stands or can be separated from the milk by centrifugal force.

Light cream contains approximately 20% fat.

Heavy cream contains approximately 30% fat.

Whipping cream contains from 35 to 40% fat.

Oils commonly used are:

Corn oil is the refined product which has been expressed by pressure from the dried crushed corn germ.

Cottonseed oil is the refined product which has been expressed from the crushed seed of the cotton plant.

Olive oil is the product expressed from the flesh of the ripe olive.

Peanut oil is obtained from the peanut germ or from the less fresh peanuts in the manufacture of peanut butter.

Solid fats.

Butter is a compact mass of fat from ripened cream with other constituents of cream included. It contains not less than 80% of fat and not more than 16% of water, and in addition it may contain coloring and salt.

Sweet butter is unsalted butter made from unripened cream.

Processed butter is made from butter of inferior quality by treating it to remove undesirable odors and flavors, then rechurning it in fresh milk and cream.

Compounds[1] are mixtures of vegetable fats, of animal fats, or of animal and vegetable fats. They are similar in appearance to lard or hydrogenated oils.

Lard[1] is the fat rendered from the fatty tissues of the hog. Lards are named according to the methods used in their manufacture: prime, steam kettle rendered, dry rendered, drip rendered, and hydrogenated.

Suet is the white, crispy fat which surrounds the kidney of beef cattle.

Margarin is a product made from bland fats, other than butter, by emulsification in ripened milk.

"Nut" margarins are produced by combining two or more vegetable oils.

"Oleo" margarins are produced by combining two or more animal fats. Or they may contain a mixture of animal and vegetable fats.

Structure of Fats

Fats are glycerol esters of fatty acids of the acetic acid series, $C_nH_{2n}O_2$ or $C_nH_{2n+1}COOH$. Only those in which n is an even number are found in natural fats.

Fat + 3 H_2O = glycerol + 3 molecules of fatty acid.

Fats differ with regard to the amount and kind of fatty acid molecules contained. Examples: Fat may contain three fatty acids which may be all of the same kind, as oleic acids; two different kinds, as one palmitic and two oleic; or three different kinds, as one molecule oleic, one palmitic, and one stearic.

The differences produced by the fatty acids in fats are due to the length of the carbon chain in a saturated fatty acid, since the longer the chain the harder the fat, and the higher the melting point. Saturated fats are harder than unsaturated fats containing fatty acids with the same number of carbon atoms.

Starch

General Information about Starch

The most important sources of starch are arrowroot, corn, potatoes, rice, sago, and wheat. The size of the starch granule differs in the different products, the smallest being found in the seeds and the largest in potatoes.

Characteristics of Starch

Starch is a white, tasteless, odorless substance which is insoluble or only very slightly soluble in cold water and other common solvents. When heated in water it absorbs water readily. This absorption of water is termed *hydration*, and in the hydration of starch two

[1] *Terminology Used in Food Preparation.* A. H. E. A.

changes take place. There is the physical change of swelling during which some rupturing of the starch granules usually results, especially under pressure, and there is the chemical change of *hydrolysis* in which some of the starch is converted into dextrin. *Dextrin*, like starch, is white, tasteless, and odorless, but unlike starch it is readily soluble and lacks the thickening power of starch. Starch may be dextrinized by applying dry heat at a high temperature, because sufficient moisture is present in the starch to permit hydrolysis to take place. Dextrinized starch is usually brown in color because of caramelization, and is sweeter and more soluble in water than starch before it is dextrinized.

Technical Vocabulary Relating to Emulsions and Starch

absorption
acidulated
acrolein
adsorption
broken emulsion
butyric acid
catalyst
coalesce
continuous phase
decomposition
dehydrate
dextrin
dispersed phase
emulsification
emulsifying agent
ester
fatty acids
glyceride
glycerol
hydration
hydrogenation
H-ion concentration
hydrolysis
insoluble
interfacial tension
linoleic acid
marinated
mayonnaise
oil globules
oleated
oleic acid
olein
organic seasonings
oxidation
palmitic acid
permanent emulsion
plasticity
rancidity
saturated
smoking temperature
stabilizer
stearates
stearic acid
surface tension
suspension
temporary emulsion
unsaturated
viscosity

Some Approved Practices in the Preparation of Salad Dressings and White Sauces

1. To obtain the most permanent emulsion in mayonnaise, use fresh egg yolk as an emulsifying agent. Other emulsifying agents in order of efficiency are: whole egg; egg white; gelatin; starch paste; evaporated milk.
2. Have ingredients for mayonnaise at room temperature. Chilled ingredients slow up the starting of an emulsion.
3. The addition of too much acid at the beginning of the preparation of mayonnaise interferes with emulsification. A small quantity of acid may be added.
4. When preparing cooked salad dressing, mix the dry ingredients and add water and vinegar to form a smooth paste before cooking.
5. Shake French dressing and similar dressings vigorously before serving.
6. In modifying salad dressings, prepare in amounts sufficient for immediate use.

7. Do not add starch or material containing much starch directly to hot liquid.
8. Separate starch grains with fat, sugar, or cold liquid to obtain a smooth paste.
9. Stir starch mixtures until thickened.
10. Keep starch mixtures covered during cooking and cooling.
11. Serve starch mixtures that cannot be covered as soon as possible.
12. Have starch mixtures thinner when finishing cooking than the desired consistency.
13. The consistency of long-cooked starch mixtures containing acid will be thinner than at the beginning.
14. Use twice as much brown flour as white flour for thickening, when substituting browned flour for white.
15. To give color to gravy use browned flour.

Add other approved practices.

List each of the approved practices in the preparation of salad dressings and white sauces in the blank space opposite the fact or principle which affords a scientific basis for the practice.

Scientific Facts and Principles	Approved Practices
	Emulsions
1. The high surface tension of water tends to prevent the emulsification of water with oils.	
2. Certain substances which lower the interface tension of oil droplets in water will aid in the producing of a perfect emulsion. Some colloids are good emulsifying agents.	Use egg yolks, whole egg, egg white, gelatin, or starch paste as an emulsifying agent.

Scientific Facts and Principles	Approved Practices
3. The emulsion is not stable if more water is present than can be bound by the colloid.	
4. The hydration capacity of the common food proteins and other colloids is increased by acids.	In making mayonnaise, dilute the egg with a small quantity of acid before adding the oil.
5. Within ordinary limits, temperature has little effect in the preparation of satisfactory emulsions.	Have ingredients at room temperature. Chilled ingredients slow up the starting of an emulsion.
6. Moisture and sugar in salad dressings may cause fermentation on standing.	
7. Salt and vinegar check fermentation.	
8. Many highly hydrated colloids lose their water upon freezing.	

Scientific Facts and Principles	Approved Practices
	Starch and Dextrin
9. Starch has great capacity for absorbing water (hydration). The absorption is rapid and complete in hot water, but very slight in cold water.	
10. Starch is gel-forming, and this property is dependent upon the hydration power of starch.	
11. A starch mixture becomes stiffer upon standing.	
12. Starch is insoluble in cold water, and partially insoluble in hot water, with which it is likely to be lumpy. Starch first touched by hot water swells suddenly, forming a sticky wall around the rest and preventing it from swelling. The inside of the lump will be found to be dry starch.	Do not add starch or material containing much starch directly to hot liquid. Separate starch grains with fat, sugar, or cold liquid to secure a smooth mixture.
13. Starch granules ordinarily do not burst in cooking, but a swelling takes place in the presence of heat and moisture. Under pressure bursting takes place as in popped corn, popped rice, etc.	

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Scientific Facts and Principles	Approved Practices
14. Grinding tends to rupture the starch grains, and ruptured grains are more soluble in water than before rupturing.	
15. Starch mixtures are poor conductors of heat.	Stir starchy products until thickened.
16. Starch hydrolyzes readily when heated in the presence of acid, and eventually forms substances which lack thickening power.	
17. When moisture evaporates from the surface of a starch-gel during cooking or afterward, a skin forms on the surface.	
18. Pure dextrin is lacking in taste and color. Color results from caramelization of sugar during dextrinization process.	To give color to gravies brown the flour.
19. Cooked dextrin has less power of hydration than starch.	

Suggested Readings

Fats, Oils, and Emulsions

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Chapter VI

PROTEINS AND PROTEIN FOODS

Proteins are compounds of carbon, hydrogen, oxygen, nitrogen, and sometimes phosphorus. Protein foods are the only ones containing nitrogen. Proteins yield on hydrolysis twenty-six different amino acids. The most important sources of protein are meat, poultry, fish, eggs, and milk.

Suggested Questions for Proteins and Protein Foods

1. Distinguish between certified, pasteurized, raw, evaporated, and condensed milk.
2. Is it required by law to pasteurize milk in this state?
3. Will cream rise in evaporated milk? Explain.
4. What is the effect of boiling on the different constituents of milk?
5. Which would contain more calcium—cottage cheese (using soured milk) or rennet curd cheese? Explain.
6. With what constituents in milk is the calcium associated?
7. How does the composition of cheese affect its use for cooking?
8. What are the best conditions for cheese cookery in rarebit? In escalloped dishes? In soufflés? Any difference? Explain.
9. What is the cause of stringy Welsh rarebit?
10. What special technique must be employed in preparing omelets?
11. What is the baking temperature of dishes containing eggs?
12. What may cause an omelet or soufflé to shrink? to fall?
13. Why is the starch cooked separately from the egg when used as a thickening agent in the same recipe?
14. Compare the composition of the yolk and white of egg.
15. How does the difference between yolk and white affect products in which either one or the whole egg may be used (custards, etc.)?
16. Which is the best emulsifier of oil—whole egg, egg white, egg yolk? Explain.
17. What is the cause of curdled firm and soft custard? How would you restore each to a satisfactory standard? What happens in the process?
18. What is the effect of increasing the sugar in plain custards on cooking temperature and time?
19. Account for the dark greenish color produced on the surface of the yolk of a hard-cooked egg. How may it be prevented?
20. Why does egg cookery (in shell or out of shell) produce such variable results in the finished products?
21. Name the important meat proteins. Give the sources of each.
22. What are the purposes of cooking meat (give three)? How do these apply to different meat cuts?
23. What methods of testing meat are used as a test of doneness? Which tests would you recommend? Explain your answer.
24. What effect does salt have upon the surface of meat?
25. Why is a part of meat for soups and stews frequently seared?

26. At what temperature does the coagulation of meat proteins begin?
27. What methods of cooking may be used to make certain cuts more tender? Illustrate each by specific meat preparations.
28. What mechanical methods prior to cooking may be employed to soften the connective tissue?
29. What cuts of meat or meat dishes may be satisfactorily cooked to definite interior temperatures?
30. How many interior temperatures do we have for beef, lamb (or mutton), pork, and veal? Explain.
31. Name the factors which will affect the minutes per pound for cooking of roast beef.
32. What parts of the animal produce tender cuts? What are the objectives in cooking such cuts?
33. What parts of the animal produce less tender cuts? What are the objectives in cooking such cuts?

Gelatin

34. Does gelatin dissolve in cold water? Hot water? Explain.
35. Why is it possible to incorporate air into gelatin?
36. How much does a gelatin solution increase in bulk when beaten? How does this affect flavoring?
37. What is the effect of fresh pineapple on the "jellying property" of gelatin? Explain.
38. When are solids added to plain gelatin? Explain.

In order to understand proteins and their changes it is well to understand the following terms:

Coagulation refers to the alteration in the properties of a substance from those of the original, i.e., by action of heat or enzymes. Heat coagulation of proteins is influenced by temperature, time of heating, electrolytes, sugar, reaction of solutions, and water content. Coagulation decreases dispersion and solubility.

Peptization is the physical reverse of coagulation. It increases dispersion and solubility. Chemical, mechanical, and enzyme actions affect peptization.

Precipitation is the aggregation of particles larger than colloidal range. This process may or may not follow coagulation.

The most important food proteins are the albumins, globulins, albuminoids, and phosphoproteins.

The *albumins* are simple proteins found in egg (egg albumin), milk (lactalbumin), peas (legumelin), blood (serum albumin).

The *globulins* are simple proteins found in egg (ovoglobulin) and in meat.

The native *albuminoids* are simple proteins. The organic constituents of the skeletal structure of animals are included in this group, e.g., elastin from ligament, collagen from tendon, cartilage, bone, and ligament.

The *phosphoproteins* are compound proteins found in milk, as casein, and in egg yolk, as vitellin.

Milk and Milk Products

Milk should form the basis of all normal diets both for children and adults. Besides containing excellent protein, milk contains vitamins and minerals which are valuable for building and protective purposes.

Milk may be described as "essentially an emulsion of fat in a watery solution of sugar and mineral salts, and with protein in a colloidal suspension."[1]

The kinds of milk in common use are as follows:

Whole milk is milk from which no constituent has been removed.

Skim milk is that portion of the milk which remains after the cream has been substantially removed.

Butter milk is that which remains after the fat has been removed from milk or cream by churning.

Certified milk is raw milk produced under regulated and sanitary conditions.

Pasteurized milk is milk which has been subjected to a temperature high enough to destroy pathogenic bacteria (140–145°F.) and then promptly cooled to 50°F. or lower.

Evaporated milk is whole milk which has been sterilized and then concentrated under vacuum at a temperature of 54° to 60°F.

Sweetened condensed milk is a concentrated whole milk preserved by the addition of sucrose instead of by sterilization.

Malted milk is a dried mixture of malt and milk.

Dry whole milk is whole milk from which the water has been removed (about 3% remains).

Dry skim milk is fresh, sweet milk from which the fat and water have been removed, leaving a fine creamy-white powder, containing not more than 5% moisture.

Cream consists of the fat of milk with a portion of the other solids and water of milk. The content of butter fat is approximately 18% in light cream, 30% in medium cream, and 36 to 40% in heavy cream.

Composition of Milk

The approximate composition of cows' milk is: Water, 87%; proteins, 3.3%; fat, 4.0%; carbohydrates, 5.0%; minerals, 0.7%.

The proteins are casein, lactalbumin, and lactoglobulin. The fat has glycerol and fatty acids (butyric, palmitic, stearic, and others). The sugar is lactose. The minerals are in the form of phosphates, chlorides, and citrates of calcium, magnesium, potassium, and sodium. There are small amounts of iron and iodine.

Milk contains vitamins A, B_1, C, D, E, and B_2 (or G).

The fat of milk contains carotene and xanthophyll, and the whey contains lactochrome.

The enzymes in milk are proteases, diastase, lipase, catalase, peroxidase, solalase, and reductase.

A comparison of the composition of the milks is given in Table 8.

[1] Eckles, C. H., Combs, W. B., and Macy, H. M. *Milk and Milk Products*, p. 16. McGraw-Hill Book Co., 1936.

TABLE 8

AVERAGE COMPOSITION OF FRESH AND DRIED, EVAPORATED AND CONDENSED MILK*

Kind	Water %	Protein %	Fat %	Lactose %	Ash %
Whole, fresh	87.27	3.55	3.62	4.82	0.71
Whole, dried	2.00	26.91	28.65	36.50	5.94
Skim, fresh	90.35	3.72	0.15	4.98	0.80
Skim, dried	3.89	35.42	1.74	48.74	8.08
Whole, evaporated	73.63	6.71	8.22	10.13	1.55
Whole, sweetened condensed	27.03	7.85	8.99	12.65 +41.65 sucrose	1.76

* ROGERS, L. A. (by associates). *Fundamentals of Dairy Science.* The Chemical Catalog Co., New York, 1928.

Structure of Milk

To know the structure of milk is important since an understanding of coagulation is dependent upon this.

"Structurally, milk consists essentially of a microscopic dispersion of fat in an aqueous plasma containing molecularly dispersed lactose and certain mineral salts, and colloidally dispersed proteins, of which calcium caseinate and lactalbumin predominate, as well as a colloidally dispersed calcium phosphate $Ca_2H_2(PO_4)_2$. The important colloids of milk, therefore, are calcium caseinate, lactalbumin and calcium phosphate."[1] "Milk coagulation is the destruction of the physical state of its chief colloids, calcium caseinate, lactalbumin and calcium phosphate."[1]

Coagulation in milk is due to an aggregation of particles of casein. Milk may be coagulated by (1) the acidity from the action of lactic acid bacteria, (2) addition of rennin, (3) heating, (4) salts, (5) tannin in foods.

Effect of Heat on Milk

When milk is heated the following changes may be produced: (1) surface film is formed (chiefly calcium caseinate); (2) a coating is formed on the bottom of the utensil; (3) continued heating coagulates the casein; (4) odor and flavor are altered; (5) viscosity is increased; (6) sugar may caramelize; (7) enzymes are destroyed; (8) vitamin C is partially destroyed.

GENERAL INFORMATION ABOUT CHEESE

Cheese is a complex food product containing all the solid constituents of milk in a concentrated form. The composition of cheese varies according to the ingredients used, but

[1] PALMER, L. S. *The Chemistry of Milk and Dairy Products Viewed from a Colloidal Standpoint.* J. Ind. and Eng. Chem. 16:631–635, 1924.

consists mainly of coagulated casein, fat, and water; it is also high in calcium and sulphur, and has a fair amount of iron.

Ripening is produced by the growth of molds or bacteria. The color, odor, flavor, texture, and composition of cheese are changed in the ripening process. The location of the ripening agent in the cheese determines the type of cheese, and to some extent its size.

The variety of cheese depends upon the kind of milk used, the proportion of cream in the milk, the amount of moisture, and the nature of the ripening process. Processed cheese is prepared by grinding a natural cheese and adding some material such as butter and condiments to it. Cheeses may be classified as follows:

Soft Cheeses.—Microorganisms grow on the surface of the soft cheese; therefore these cheeses must be small.

Unripened.

Cottage cheese is made from soured skim milk and heated to separate the curd from the whey.

Cream cheese is similar to Neufchâtel except that it is made from milk containing 6% fat.

Neufchâtel is made from whole milk containing 4% fat. It has a clean, sour, or lactic acid flavor, is smooth in texture, and free from gas holes. It is a good spreading cheese.

Ripened by molds.

Camembert is made from whole or partly skimmed milk, has a strong odor and flavor, and varies in texture from nearly fluid to the consistency of butter. It has a feltlike rind caused by mold.

Brie is made from partly skimmed milk, has a texture that is waxy to semi-liquid, a sharp flavor, and a very pronounced odor. The red color of the surface is due to the molds used in the ripening. It is usually dipped from the container with a spoon.

Ripened by bacteria.

Limburger is made from whole milk and has a strong odor and flavor. The characteristic flavor is developed during the ripening process by bacteria. The odor is confined almost entirely to the rind.

Liederkranz resembles Limburger in flavor, but is much softer.

Hard Cheeses.—In hard cheese the microorganisms are distributed throughout the cheese mass at the beginning of ripening so the cheese may be large or small.

Semi-hard cheeses.

Ripened by molds.

Gorgonzola is a semi-hard cheese made from whole milk and ripened with blue-green molds. The surface is covered with a substance resembling clay, and the cheese has a waxy or crumbly texture with a flavor similar to that of Roquefort.

Roquefort is made from goats' milk (whole) which is ripened by the blue-green mold, *Penicillium roqueforti*, which gives it a mottled appearance. It comes wrapped in tinfoil and has no definite rind. It has a strong, slightly salty flavor. Only cheese coming from the Roquefort caves, France, can be known as the real Roquefort, and is identified by a "Sheep in Oval" trade-mark.

Blew cheese is similar to Roquefort, but it is made in various countries, and usually from cows' milk.

Stilton is made from whole milk, is ripened by blue and green molds, and has the same mottled effect as Roquefort. It has a very wrinkled and rigid skin or rind.

Ripened by bacteria.

Brick is made from whole milk. It is named from the size and shape in which it is sold. It has a sharp, sweetish flavor, with a mellow, smooth texture.

Münster is similar to Brick and Limburger, and gets its name from Münster, Germany, where it was first made.

Very Hard Cheeses.

Without gas holes.

Cheddar is made from whole sweet milk, with a flavor which varies from the mild flavor of green uncured cheese to the strong flavor of old cured. Its color varies from white to deep yellow. Pineapple cheese, a form of Cheddar, has a very high flavor, and gets its name from its shape. It is bright yellow, and is varnished on the surface.

Edam is made from whole or partly skimmed milk. It is made in the form of round red balls weighing from 3 to 4½ pounds. It is dry and crumbly with a clean, pleasantly salty taste.

Gouda is made from whole milk and is similar to Edam cheese. The rind is colored with saffron.

With gas holes.

Emmental and Gruyère are Swiss cheese with a mildly salty flavor and smooth firm texture. They are made from whole or partly skimmed milk.

Swiss has a peculiar sweet flavor and is characterized by very large holes. The size and shape of the holes indicate the stage to which the cheese has been allowed to ripen. Its color varies from white, which is the American variety, to yellow, which is the imported. It is made from whole milk.

Parmesan is a very hard, granular Italian cheese, so hard that it is usually grated. It is made principally from partly skimmed milk.

Standard for Cooked Cheese

Cooked cheese should be soft, moist, not dry, tough, or stringy.

Meat, Poultry, and Fish

Meat, poultry, and fish are important sources of protein, and in some cases of fat, but the quantity of fat varies greatly. They contain important minerals, iron, and phosphorus. Small quantities of some vitamins are present.

Structure

Muscle is composed of multi-nucleated cells which vary in size but average about 1 inch in length and 0.05 inch in diameter. They are tapered at either end, and are fastened together by connective tissue into small bundles (fasciculi) which in turn are fastened together to form the muscle.

Composition

Muscle is composed of water, proteins, fat, minerals, extractives, carbohydrate, and vitamins, and in addition contains enzymes and pigments. The muscle cell contains albumins and globulins. The connective-tissue proteins are collagen (white) and elastin (yellow). The muscle tissue may have fat deposited within it, which is called marbling, or the muscle may be covered with adipose tissue. Carbohydrate is present in muscle as glycogen, most of which is changed to lactic acid during ripening. Glycogen is found in greater amounts in the liver.

The most important mineral salts are sodium chloride, phosphates, and sulphates, although other salts are found.

The most important nitrogenous extractives are creatin, creatinine, carnosine, uric acid, and amino acids. A part of the flavor of meat is due to these extractives. Lactic acid, a non-nitrogenous extractive, is important in the ripening of meat.

Proteolytic, lypolytic, and amylolytic enzymes are present which act upon the proteins, fats, and carbohydrates.

The pigment is chiefly hemoglobin.

Meat contains vitamins A, B_1, C, and B_2 (or G) in varying amounts, B_2 (or G) being the most important. The internal organs have more vitamins than ordinary meat.

Meat Cookery

Meat is cooked to make it more palatable and appetizing by modifying the color and flavor, to destroy microorganisms, and to increase tenderness if necessary.

Changes in Meat during Cooking

Water is lost during cooking, and the soluble constituents, especially nitrogen and phosphorus, are increased. Heat coagulates the soluble proteins, causing the meat to become more firm. Hemoglobin is decomposed at 147°F. (64°C.), and hematin is formed which gives cooked meat its gray-brown color. Fat of meat from different animal fats is melted at different temperatures; it becomes liquid and seeps through the muscle tissue. Decomposition occurs in the surface fats and the meat may become brown. Enzyme action is stopped when the interior temperature reaches 140° to 150°F.

Classification of Meat (according to tenderness)

In order to choose the best methods of cooking meat one needs to know something about its tenderness. It may be classified as follows:

Tender: little connective tissue, well marbled, short small fibers, large muscle bundles.
Semi-tender: more connective tissue, longer fibers, medium muscle bundles.
Less tender: much connective tissue, not much marbling, fibers coarse, small muscle bundles.

Methods of Cooking

The methods of cooking meat depend upon whether the cuts are tender or less tender, and upon personal choice. The chief methods are:

Braising.
Broiling.
Deep-fat frying.
Frying.
Pan-broiling.
Roasting.
Simmering.
Soup making.
Stewing.

Losses in Cooking Meat

Cooking losses are important as increased losses may affect the finished product. Cooking losses depend upon the composition of the meat, especially the quantity of fat, both the internal and external temperatures, time of cooking, the weight of the meat, the surface area, and the method of cooking.

Time Required for Cooking Meat and Use of Oven Thermometer

The factors which must be taken into consideration in cooking meat are the gross composition of the meat, such as the proportion of fat, lean, bone, gristle, also the weight, surface area, oven temperature, the stage to which the meat is cooked—rare, medium, or well done, and the initial temperature of the meat.

Since so many variable factors affect the time of cooking, it is not possible to have a definite time per pound for cooking cuts of meat. However, meat can be cooked satisfactorily by using a thermometer and cooking cuts to the interior temperature which has been obtained experimentally for each cut. Interior temperatures for roasting meat are given in Table 9.

To insure success in roasting meat, use a meat thermometer. Place thermometer so that the bulb reaches the center of the large muscle. The interior temperature reached varies with different meats and with the standard desired (rare, medium, or well done).

TABLE 9

Interior Temperatures for Roasting Meat

	Degrees in Centigrade and Fahrenheit					
	Well-done		Medium		Rare	
	°C.	°F.	°C.	°F.	°C.	°F.
Beef	76	170	71	160	60	140
Lamb, leg	83	180	79	175		
Pork, fresh	85	185				
Pork, cured	76	170				
Poultry	85	185				
Veal	76	170				

Standards for Cooked Meat

The qualities in meat to be conserved or produced in meat when cooked are: aroma, flavor, tenderness, quantity and quality of juice.

Roast beef.

Rare: Center a bright rose-red, shading into a lighter pink toward the outer portions, changing into a dark gray in layer underlying outer browned crust. Juice a bright red.

Medium rare: Center and most of slice a light pink; gray layer underlying crust extends a little toward center; juice a light pink in color.

Well done: Interior is brownish gray; juice is either colorless or slightly yellow.

Roast lamb.

Well done: Interior brownish gray; firm but not crumbly; tender; juicy; juice clear.

Medium rare: Same as for well done except color is a light pink and the juice pink.

Roast pork.

Interior grayish white without a tinge of pink; firm, not dry or crumbly; tender; juicy (juice no pink tint). *Always well done.*

Poultry.

White meat: Grayish white without a tinge of pink, not stringy, tender and juicy, always well done.

Dark meat: Same qualities as white except muscle will be brownish gray.

Veal.

Firm, not crumbly; tender; juicy; juice clear or faintly pink.

Poultry

Poultry is any domesticated bird which serves as a source of food. In order of their importance to man, poultry includes chickens, turkeys, ducks, geese, guinea fowl, pigeons.

The general composition of poultry is approximately that of meat, varying with chickens, ducks, and geese. The same methods of cooking may be used.

Chickens may be classified as tender (under one year old), and less tender (one year or over).

TABLE 10

Classification of Chickens, with Methods of Cooking

Approximate Size and Sex	Characteristics	Common Market Term	Method of Cooking
1 to 2½ lbs. Either sex	Soft-meated, tender, rear end of breast bone or keel flexible, 8 to 12 wks. old	Broiler	Roasting Frying Broiling
2½ to 3½ lbs. Either sex	Differs from above only in size and age, 14 to 20 wks. old	Fryer	Broiling Roasting Frying Braising (fricassee)
Over 3½ lbs. Either sex	Tender, soft-meated, keel bone flexible, 5 to 9 months old	Roaster	Roasting Frying
4 lbs. and over Unsexed male	Tender, soft-meated, usually 7 to 10 months old	Capon	Roasting Frying
3½ to 5½ lbs. Young hen	Tender, keel bone flexible, 4 to 9 months old	Pullet	All methods of cooking
2½ lbs. and over Female "old hens"	Less tender, rear end of breast bone, or keel, is rigid	Fowl	Simmering Steaming Stewing
3 to 6 lbs. Male	Darkened and toughened flesh	Cock	Simmering Chiefly soups

Fish

The general composition of fish is much the same as that of meat, though it contains less fat. Fish is always tender because of lower connective-tissue content, and it breaks up readily. The methods of cooking tender cuts of meat may be used for fish cookery.

Eggs

Eggs are one of the chief sources of excellent protein in the diet. They are also valuable sources of minerals and vitamins, and the yolk contains a significant quantity of fat.

Eggs are very important in cooking because of their property of being coagulated by heat and their power of emulsifying. These qualities make them useful for leavening, thickening, binding, and clarifying; they are useful also in coloring and flavoring.

Structure of Eggs

Eggs are made up of the outer shell, two thick white membranes, the white, vitelline membrane, yolk, and the germ spot.

The shell is a rigid porous structure composed chiefly of the phosphate and carbonates of lime, and is coated on the outside with a mucilaginous substance which protects it. Just within the shell are the two white membranes which separate at one end to form the air space when the egg cools after it is laid.

The white is composed of two parts, the outer or thin, and the inner or thick, portion. The yolk is surrounded by the thin vitelline membrane. The germ spot is found in the yolk of both fertile and infertile eggs.

Cords which hold the yolk in place are called chalazae. These allow the yolk to rotate so that the germ spot is always uppermost.

For diagram showing internal structure of egg, see Lowe, *Experimental Cookery*, Second Edition, page 325.

Egg Quality

The quality of eggs depends upon the proportion of thick to thin white and the percentage of yolk solids. There should be a high percentage of thick white and of yolk solids.

Factors which affect the quality of eggs are the diet of the hen, season of year, the characteristics of the hen and the care in handling.

Specifications for Official United States Standards for Individual Eggs

Standards for Eggs with Clean Sound Shells

U. S. Special.

The shell must be clean, sound, and normal.

The air cell must not exceed ⅛ inch in depth and must be regular.

The yolk must be well centered, its outline indistinct, and it must be free from visible germ development and other defects or blemishes.

The white must be firm and clear.

U. S. Extra.

The shell must be clean, sound, and normal.

The air cell must not exceed $\frac{2}{8}$ inch in depth and must be regular except in the retail grade of U. S. Extra, when the air cell may be slightly tremulous.

The yolk must be fairly well centered, and its outline may be moderately defined. It may be slightly mobile, but must be free from visible germ development and practically free from other defects or blemishes.

The white must be firm and clear.

U. S. Standard.

The shell must be clean and sound but may be slightly abnormal.

The air cell must not exceed $\frac{3}{8}$ inch in depth and may show movement not in excess of $\frac{1}{2}$ inch.

The yolk outline may be well defined. The yolk may be mobile and may show slightly visible germ development and other definite but not serious defects.

The white must be reasonably firm and clear.

U. S. Trade.

The shell must be clean and sound but may be abnormal.

The air cell may be over $\frac{3}{8}$ inch in depth, may show movement in excess of $\frac{1}{2}$ inch, and may be bubbly or free.

The yolk may be plainly visible. It may be freely mobile and cast a dark shadow. It may show clearly visible germ development, but no blood. It may show other serious defects.

The white may be weak and watery.

Standards for Eggs with Dirty Sound Shells

Standards are provided for three qualities of dirty sound-shell eggs, namely, U. S. Extra Dirty, U. S. Standard Dirty, and U. S. Trade Dirty. The specifications for dirty-shell eggs of each of these three qualities are the same as for the corresponding quality of clean-shell eggs except that the shell may be only slightly stained or slightly dirty in the U. S. Extra Dirty and it may be stained or dirty in the U. S. Standard Dirty and the U. S. Trade Dirty.[1]

Aging of Eggs

The most important changes which take place in eggs as they age are the loss of water, the white becoming less viscous and the yolk less firm, the enlargement of the air space and the germ spot, the weakening of the chalaze membrane, and the increase in *p*H due to loss of carbon dioxide.

Preservation of Eggs

Eggs may be preserved or kept from one season to another by (*a*) storing at a low temperature, (*b*) drying, (*c*) freezing, and (*d*) excluding the air and retaining the carbon dioxide by covering with water glass or by oil dipping.

Gelatin

Gelatin is an incomplete protein. The food value is not great, but it forms an excellent "carrier" for fruits, vegetables, meats, and fish. Gelatin also acts as a stabilizer in mayonnaise dressing and gives smoothness to products such as frozen desserts and candy. It incorporates air when beaten at the right stage of gelation, forming whips and sponges.

Types of Gelatin

Pulverized gelatin hydrates most rapidly. It is used extensively in trade preparations where sugar and flavoring are added.

[1] U. S. D. A. Bur. Econ. *Official U. S. Standards for Individual Eggs.* Washington, D. C., 1934.

Granulated gelatin hydrates less rapidly. It is satisfactory for home use.

Shredded gelatin hydrates slowly, depending upon the thickness of the shred. It is used commercially.

Sheet gelatin hydrates very slowly, depending somewhat upon thickness. It is used commercially.

Standard for Gelatin Salads and Desserts

A molded gelatin salad or dessert should have a smooth and glossy surface. It should quiver, but retain its shape. Solid materials should be evenly distributed throughout the mass or form a design. It should have a pleasing color, and a distinctive flavor.

Technical Vocabulary for Protein Foods

adipose
agar-agar
air cell
albumin
amino acid
Bacillus acidophilus
Brie
broiling
bromelin
calcium
calcium caseinate
calcium lactate
Camembert
caramelization
carbonates
carotene
casein
certified
chalaze
Cheddar
coagulate
collagen
colloidal
condensed
congeal
connective tissue
curd
cystine
denatured
Edam
elastin
embryo
evaporated
extensibility
extractives
eye muscle
ferrous sulphide
fondue
gel
germ spot
globulin
glycogen
Gruyère
hemoglobin
homogenization
hydrated
incomplete protein
lactic acid
mucilaginous
mucoids
myosin
osmosis
paracasein
Parmesan
*p*H
pasteurized
putrefaction
rennin
rigor mortis
ripening
Roquefort
sac
scoring
searing
serum
soufflé
sterilization
viscous
vitellin
whey
whip

Some Approved Practices in the Preparation of Protein Foods

1. To combine acid flavor with milk, combine just before serving, and serve at once (cream of tomato or asparagus soup).
2. Cook products containing cheese at a low temperature.
3. Place soufflé dish in a pan of water when baking.
4. Cook less tender cuts of meat by moist heat methods (stewing, braising, simmering, and soup making).
5. Use a high temperature for searing meat only.
6. Do not wash meats. Wipe with a damp cloth.
7. For soup and stews cut meat in small pieces to expose more surface.
8. Roasts may be salted before cooking since a comparatively small surface is exposed.
9. Salt steaks and chops, where a large cut surface is exposed, near the end of the cooking period.
10. Add salt in soup or stew making in the early part of the cooking period.
11. Cook less tender cuts of meat for a longer time than the more tender.
12. Cook meat slowly with moist heat when extracting collagen as for jellied veal.
13. Add vinegar or tomato juice to meat in preparing Swiss steak.
14. Use a low temperature in preparing meat soups and stews.
15. Prepare soft custards with water in the lower part of the double boiler below the boiling point.
16. Eggs for scrambling may be slightly diluted with a liquid such as water or milk.
17. Soups may be clarified by the use of egg white.
18. When poaching eggs start eggs in hot liquid.
19. Some of the liquid in a gelatin recipe must be boiling.
20. Add cold water to granulated gelatin and allow initial hydration before addition of hot or boiling water.
21. If necessary to make gelatin dessert in a short time increase the amount of gelatin and cool quickly. Keep in a cool place.
22. To obtain maximum stiffness with the same concentration of gelatin, cool slowly to room temperature and then place in a cool place.
23. If a firmer gel is desired, the proportion of gelatin to liquid can be increased.
24. In making a whipped gelatin dessert allow it to cool to the consistency of thick honey before beating.
25. Fresh pineapple juice should be brought to the boiling point before using as it contains the proteolytic enzyme bromelin.

Add other approved practices.

List each of the approved practices in the preparation of proteins in the blanks opposite the fact or principle which affords a scientific basis for the practice.

Scientific Facts and Principles	Approved Practices
	Albumins
1. Albumin is soluble in cold water.	Eggs for scrambling may be slightly diluted with liquid (milk or water). Cut meat for soups and stews in small pieces to expose more surface.
2. Albumin is soluble in dilute salt solutions.	
3. Albumin is soluble in dilute acids.	
4. Albumin is coagulated by heat. Coagulation begins at 56°C. or 132.8°F. Coagulation is completed at 71°C. or 159.8°F.	
5. Albumin in dilute solution will produce a flocculent precipitate if agitated on heating, especially if overheated.	Soups may be clarified by the use of egg white.

Scientific Facts and Principles	Approved Practices
6. Albumin is toughened by the boiling temperature.	
7. Albumin is toughened by cooking too long a time.	
8. Albuminoids are rendered dry and hard by dry heat.	*Albuminoids* Cook less tender cuts of meat by moist heat methods (stewing, braising, simmering, soup making).
9. Albuminoids are insoluble in water and salt solutions.	
10. Collagen is unaffected by short cooking processes.	
11. Collagen heated in water from 80°C. or 176°F. to 90°C. or 194°F. is converted slowly into gelatin which is soluble in hot water.	

Scientific Facts and Principles	Approved Practices
12. Collagen is converted into gelatin more rapidly in an acid medium, either alone or in the presence of water and heat.	
13. Collagen is converted more rapidly into gelatin at or above the boiling temperature of water.	
14. Elastin is unaffected by ordinary cooking processes. It is soluble only in strong alkali or mineral acid solutions.	
15. Globulins are soluble in salt solution.	*Globulins* Salt steaks and chops, in which a large cut surface is exposed, near the end of the cooking period.
16. Globulins are insoluble in water.	
17. Meat globulins are coagulated by heat at 44°C. to 50°C. or 111.2°F. to 122°F.	Use a high temperature for searing meat only.

Scientific Facts and Principles	Approved Practices
18. Globulins are hardened by intense heat.	
19. Casein is insoluble in water.	*Phosphoproteins*
20. Calcium caseinate is coagulated by acid. Heat hastens the process.	Keep milk in a cold place—normal development of lactic acid in milk may coagulate the casein (sour milk). To combine acid flavor with milk, combine just before serving and serve *at once* (cream of tomato or asparagus soup)
21. Casein is not coagulated by heat at ordinary temperatures or when heated for short periods.	
22. Casein of milk may be coagulated by rennin producing the curd called paracasein consisting chiefly of calcium compounds of paracasein.	
23. Rennin causes optimum and most desirable coagulation at 104°F. to 108°F. (40°C. to 42°C.)	

Scientific Facts and Principles	Approved Practices
24. Milk when heated and exposed to air develops a skin consisting chiefly of calcium caseinate.	Keep milk covered to prevent skin forming. If skin forms, do not discard, beat until well broken up with a rotary egg beater.
25. The temperature at which the skin develops when milk is heated and exposed to air varies with the fat content. The higher the fat content the lower the temperature at which the skin forms.	Skin will form on a hot chocolate beverage at a lower temperature than on hot cocoa.
26. Agitation during the heating of milk prevents a skin from forming.	Stir milk as it is heating to prevent the formation of skin.
	Gelatin
27. Gelatin swells in cold water and becomes partially hydrated.	
28. Granulated gelatin is made gummy and sticky by boiling water.	
29. Hydrated gelatin dissolves readily in boiling water.	

Scientific Facts and Principles	Approved Practices
30. The time required for gelation depends upon: a. Concentration of gelatin. b. Temperature.	
31. The firmness of a gel depends upon: a. Time. b. Temperature. c. Concentration. d. Quantity of sugar. e. Acidity. f. Quantity of solid added.	
32. The proportion of gelatin to liquid depends upon: a. Type of gelatin (brand). b. Temperature. c. Time.	A basic proportion of 1 tb. granulated gelatin to 1 pt. of water is satisfactory under ordinary conditions.
33. Liquefaction of a gel may occur through decomposition caused by bacteria and enzymes.	Fresh pineapple juice should be brought to the boiling point before using as it contains the proteolytic enzyme bromelin.
34. Gelatin volume may be increased two or three times that of the liquid solution by beating at the right stage.	In making a whipped gelatin dessert allow to cool until the consistency of thick honey before beating.
35. Beating flavored gelatin reduces the amount of perceptible flavor.	

Scientific Facts and Principles	Approved Practices
36. Gelatin that has set and melted will reset more quickly than it did the first time.	
37. Gelatin is least ionized, least soluble, and swells the least at its isoelectric point (*p*H 4.7). It is cloudy at this point.	

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Chapter VII

BATTERS AND DOUGHS

Some form of bread is usually included in most meals. This may be yeast bread or rolls or quick bread (made with baking powder) in the form of muffins, biscuits, waffles, or griddle cakes. Extensive use is made of other products, which may also be classed as batters and doughs, but which are richer than the breads; cakes, cookies, and pastry are the most common examples. Foods made from batters and doughs are chiefly energy foods because of their high carbohydrate content.

Suggested Questions on Batter and Dough Studies

1. Distinguish between bread and pastry flour.
2. Why is wheat flour used in making bread?
3. Why does the amount of liquid vary in a recipe when one flour is substituted for another?
4. Can you make a light muffin from corn meal alone? Explain.
5. Name the qualities of gluten which make it desirable in some batters and doughs.
6. What is the effect on gluten formation of the addition of egg? of sugar? of fat?
7. Explain two methods by which air may be introduced into a flour mixture.
8. How is soda introduced when it is used with sour milk in a recipe as a leavening agent? Explain.
9. What are the acids used in baking powders?
10. What determines the rapidity with which baking powders react?
11. What is the function of starch in baking powder? Of egg whites?
12. Give the basis upon which you would judge a baking powder for desirability.
13. The leavening from 1 teaspoon of soda is equivalent to the leavening from how much baking powder?
14. Why is the fat added before the liquid in preparing biscuits?
15. What may be the cause of brown spots in biscuits?
16. Why do milk biscuits brown more readily than water biscuits?
17. What is the effect of under-mixing a biscuit? Over-mixing?
18. Is it possible to mix biscuits some time before baking? Griddle cakes? Popovers?
19. Account for the difference in amount of baking powder in biscuits and waffles.
20. If 1 cup of sour milk and ½ teaspoon soda were used in biscuits, how much baking powder would be used? Explain.
21. Why is it important to have the fat finely divided when making pastry?
22. What is the effect of the addition of too much water to pastry dough?
23. Which will require less water, pastry or bread flour?
24. Why can bread flour be used in pastry with satisfactory results?
25. Why is the selection of the fat important in pastry making?
26. Explain why a plastic fat with a high percentage of unsaturated glycerides is desirable for pastry.
27. What is the difference in the texture of a pastry made with oil and with solid fat? Explain?

28. What is the difference in the texture of pastry made by the hot-water method and by cutting in the fat?
29. What are the leavening agents in pastry?

Quality of Batter and Dough Products

The quality of batter and dough foods is modified greatly by the conditions of preparation and cooking. *To obtain quality products* one should (1) use suitable ingredients in correct proportions, (2) measure accurately, (3) combine ingredients with proper manipulation, (4) bake at the correct temperature for the proper length of time, and (5) either serve at once or cool and store product under conditions which will bring about the least deterioration. The standards for different products are described on page 82.

Equivalent Measures

It is often convenient to know the equivalents of common measures. These are furnished in Table 11. Inexpensive spoons and cups in fractional sizes, as well as standard-size cups

TABLE 11

EQUIVALENT MEASURES

Measures		Approximate Volume
1 teaspoon (t.)	= ⅓ tablespoon (tb.)	= 5 cc.
1 tablespoon	= 1/16 cup (c.)	= 15 cc.
1 cup	= ½ pint (pt.)	= 237 cc.
1 pint	= ½ quart (qt.)	= 474 cc.

upon which the fractions are marked, are on the market. If these are not available, fractions of cups may be accurately measured with a tablespoon.

Manipulation Needed to Obtain Accurate Measurements

Accurate measurement is essential if quality products are to be produced. Different ingredients require different manipulation in order to obtain accurate measurements.

Some suggestions for measuring follow.

Liquid. Fill measure as full as possible without spilling, or if only a portion of the measure is desired, fill until liquid reaches desired line on the cup. Measure with cup sitting on a flat surface, and be sure to empty completely.

White flour. Sift once, and spoon gently into a measuring cup until it overflows. Level with the edge of the spatula. Do not shake the cup or press down the flour.

Whole grain flour or meal. Stir but do not sift. Place flour in cup and level as with white flour.

Sugar. Measure as for whole wheat flour. Sift only if the sugar is lumpy.

Confectioner's sugar. Roll to remove lumps, sift, and measure like white flour.

Brown sugar. Roll or place in a hot oven for a few minutes to remove lumps. Pack solidly into measuring cup and press down with spoon. If brown sugar is kept in an air-tight can it will not become lumpy.

Baking powder. Stir powder in can. Fill spoon heaping full and level off with edge of spatula.

Fat. Fat is most easily measured if it is at room temperature. It may be measured in several ways: (1) Pack solidly into cup or spoon, leaving no air spaces. Level off the top with edge of a spatula. (2) Pour cold water into the cup leaving space equivalent to the amount of fat to be measured. Add the fat until the water is level with the top of the cup, being sure to push the fat below the surface of the water. Pour off the water. (3) Use marked or separated portion of the pound package. For example, butter is frequently sold with 4 quarter pounds in the pound package. Remember that a pound of butter is equivalent to 2 cups.

Ingredients in Batters and Doughs

The *essential ingredients* are: flour, liquid, and leavening. Other ingredients are added in varying combinations and amounts and change the color, texture, and flavor of the product as well as the food value. In addition to the essential ingredients many others are commonly found in batter and dough products, such as eggs, fat, sugar, and flavoring. Nuts and fruit are often added.

It may be helpful to understand the functions that each ingredient serves. *Structure* is given to the product by the gluten and the starch in the flour and the protein in the egg. The product may be *leavened* by one or more of the following: the gluten of the flour, the air incorporated in the beaten eggs (especially when the whites are beaten separately), the steam produced from the liquid ingredients when the product is cooked, and most often from chemical leavening agents. The product gets its *weight* from the starch of the flour, and the sugar and fat that are added. Other ingredients are valuable chiefly for *flavor* or *color.*

From Table 12 it will be possible to see the types of batters and doughs used for the most commonly prepared products.

TABLE 12

CLASSIFICATION OF BATTERS AND DOUGHS ACCORDING TO PROPORTION OF FLOUR TO LIQUID

Type	Approximate Amount of Flour to 1 Cup of Liquid	Description	Examples
Pour Batter	1 c.	Thin enough to pour	Popovers, griddle cakes, waffles, and cream puffs
Drop batter	2 c.	Thin enough to drop from spoon	Cake, muffins, gingerbread, drop biscuits, drop cookies
Soft dough	3 c.	Thick enough to be handled on board	Baking powder biscuits, and yeast bread and rolls
Stiff dough	4 c.	Stiff enough to be rolled out on board	Pie crust, noodles, rolled cookies

Table 13 gives the proportions of ingredients in some batters and doughs. A study of this table shows the differences in ingredients in the ordinary products which are prepared, and as the products are made, thought should be given as to the effect of the different ingredients which are added to the essential ingredients mentioned.

Functions of Ingredients in Batters and Doughs

Each ingredient in batters and doughs serves definite functions because of its properties. Liquid acts as a solvent of other ingredients and helps to carry them through the mix-

TABLE 13

Relative Proportions of Ingredients in Some Batters and Doughs

Product	Liquid	All-Purpose Flour	100% Fat	Sugar	Egg	Leavening Agent	Salt	Flavoring	Miscellaneous
Popovers	1 c.	1 c.	2 t.	—	2	—	½ t.	—	—
Griddle cakes	1 c.	1¼ c.	0–2 tb.	0–1 tb.	1	2½ t.	½ t.	—	—
Gingerbread	1 c.	1½ c.	2 tb.	¼ c. ½ c. molasses	1	¼ t. soda 2 t. bkg. powder	½ t.	1½ t. spice	—
Muffins	1 c.	2 c.	2–4 tb.	1–2 tb.	1	4 t.	½ t.	—	—
Baking powder biscuit	1 c.	3 c.	3–6 tb.	—	—	4 t.	1–1½ t.	—	—
Yeast bread	1 c.	3 c.+	1–3 t.	2–3 t.	—	½ cake comp. yeast	1¼ t.	—	—
Pastry	1 c.	4 c.	1 c.	—	—	—	2 t.	—	—
Crisp white cookies	1 c.	8 c.	2 c.	4 c.	4	2 t. soda 4 t. bkg. powder	2 t.	4 t.	—
Butter Cakes		Cake Flour							
One egg	1 c.	2½ c.	⅓ c.	1⅛ c.	1	3 t.	½ t.	1 t.	—
Two egg	1 c.	2¾ c.	½ c.	1¼ c.	2	3 t.	¾ t.	1 t.	—
Four egg	1 c.	3 c.	¾ c.	1¾ c.	4	4 t.	¾ t.	1 t.	—
Sponge Cakes									Cream of Tartar
White angel food	—	1 c.	—	1¼ c.	whites 1 c.	—	¼ t.	1 t.	½ t.
Yellow—five egg	¼ c.	1 c.	—	1 c.	5	—	½ t.	1 t.	½ t.

ture, so that a uniform product is obtained; liquid provides moisture for the formation of the colloidal gel. Some of the liquid is absorbed by the starch and gluten. The most commonly used liquids are sweet or sour milk or cream, or water. When water changes to steam the volume changes about 1800 times, and thus the formation of steam acts as a leavener to give lightness to the product. It should be recognized that liquid is supplied not only in the form of water or milk, but by other ingredients as well. For example, an egg of average size furnishes approximately 2 tablespoons of liquid, and 20% of honey and 25% of molasses is water.

Flour contains both starch and gluten. The starch, through the absorption of water, acts as a binder for the other ingredients and forms the body through which the gluten works. The gluten absorbs water and forms an elastic colloidal gel which stretches under tension of the gas formed by the leavening agent. This colloidal gel is hardened by heat and forms the framework for the product. A part of the starch is gelatinized in cooking. For a more detailed discussion of flour see pages 83–85 of text.

Sugar is used chiefly for flavor and to produce a fine texture in the product; but only dissolved sugar is of value. It is essential to obtain a suspension which is more easily obtained from fine than from coarse sugar. It is important to use the correct proportion of sugar, since too little produces a coarse, bread-like texture, and too much produces a moist, sticky crumb, a sugary, gummy crust, and the cake is likely to fall before the baking is finished. For a more detailed discussion of sugar see pages 100–102 of text.

Eggs. The whole egg may be used or only the yolk or the white. The yolk is valuable chiefly because it contains a high percentage of fat and gives color to the product; the white is chiefly valuable because the protein, largely albumin, assists in binding the other ingredients together and, when beaten, entangles air which acts as a leavener when the product is baked. The albumin is coagulated by heat and thus helps to form the framework for the product. In meringue, the structure is produced wholly by the egg albumin.

Fat is used in batters and doughs chiefly to give richness to the product and to make it more tender. Fat helps to retain moisture in a product, especially those which contain much fat, as in rich cakes or cookies. For a more detailed discussion of fats, see pages 46–47 of text.

Flavors help to make a product more pleasing and should be well blended. Salt gives a flavor and aids in bringing out other flavors.

Methods of Mixing Batters

The three methods commonly used in mixing batters are listed below. Variation of these methods may be found to produce good results, but those described are simple and highly satisfactory. The description given applys to "hand methods." If mechanical mixers are used, follow the directions which come with the mixers. In any method, the best results will probably be obtained if the ingredients are mixed at room temperature, 73°F. being the optimum.

Batter Method.

1. Sift dry ingredients thoroughly into mixing bowl.
2. Make a well in the flour mixture.

3. Beat eggs until very light, add liquid, and melted shortening (slightly cooled).
4. Turn liquids into the dry ingredients.
5. Mix slightly so that dry ingredients are barely moistened if baking powder breads, fritters, or muffins are being prepared.
5. Or beat about 2 minutes if making cake.

The batter method is a time saver and may be used for all pour and drop batters and less rich cookies. Prepared by this method, products are light and tender but they lack the fineness of grain and velvety texture obtained by the creaming method. They should be served while fresh.

Creaming Method.

1. Cream shortening until very plastic—about 2 minutes.
2. Add sugar gradually; continue creaming about 1½ minutes after all sugar is added.
3. Add egg beaten until very light. Beat about 2 minutes.
4. Add sifted dry ingredients alternately with the milk and flavoring. Begin and end with dry ingredients.
5. Or baking powder may be added with the last portion of dry ingredients.
6. If 2 or more eggs are used, stiffly beaten whites may be folded in last. Two tablespoons of the sugar may be added to the egg white when beating it.

Thorough combination of ingredients in each step of the process is important; the time specified for beating is only approximate and will depend upon individual differences in manipulation and such factors as temperature of ingredients, the type and quantity of baking powder and when it is added to mixture.

Quick Method.

1. Sift flour, baking powder, and salt.
2. To well-softened shortening, add unbeaten egg, sugar, milk, and flavoring. Beat thoroughly for 1 or 2 minutes.
3. Add dry ingredients all at once, and beat thoroughly for 2 minutes.
3. Or liquids may be added to dry ingredients without previous beating and all ingredients beaten for about 2 minutes.

Products with this method are similar to those with the batter method. It is satisfactory for quick breads and less rich cakes and cookies.

Any of the methods described may be used for all types of cakes and cookies. Each one will produce excellent products, but the creaming method produces the most stable emulsion, and the cake made by that method is most likely to have a fine even grain and velvety texture. This method is usually recommended for rich cakes and for those which are not to be eaten at once.

Methods of Mixing Doughs

The methods employed in combining ingredients in the doughs are very different from those used for batters. Each one is described in turn.

Biscuit Method.

1. To sifted dry ingredients, add solid fat, cut into small pieces.
2. Work in the fat with the fingers, a fork, two knives, or a pastry blender, using quick, light motions.
3. Add liquid, and stir until dough stiffens—about 20 to 30 strokes.
4. Transfer to floured board.

5. Knead lightly for about ½ minute—15 to 20 times.
6. Roll or pat into shape, until dough is ½ to 1 inch thick, working from the center toward the edge.

Pastry Method.

1. Work fat into dry ingredients in same manner as for biscuits.
2. Add water evenly to all parts and mix lightly with a fork. The mass should be just moist enough to hold together when pressed into a slightly flattened circular disc.
3. Transfer to lightly floured board or to board covered with a pastry cloth upon which flour has been sprinkled.
4. Roll lightly until about ⅛ inch thick, working from the center toward the edge.

Yeast Bread Method.

1. Soften yeast with lukewarm water.
2. Pour hot liquid over sugar, salt, and shortening. If milk is used, scald it.
3. Cool liquid to lukewarm temperature before adding yeast.
4. Add yeast and flour to make a stiff batter; beat well. (At this stage it may be left as a sponge.)
5. Add enough flour to make a firm but not stiff dough.
6. Knead until light and elastic, and until dough does not stick to board (5 minutes).
7. Place in lightly greased bowl, cover; keep between 80°F. and 85°F.
8. When doubled in bulk, punch down, let rise again to double bulk.
9. Shape into loaf, place in pan (3 by 4 by 8 inches), grease top lightly, let rise again to double bulk.

For further explanation of methods of combining ingredients in batters and doughs, see Lowe, *Experimental Cookery*, Second Edition, pages 458–59 and 481–93.

In Table 14 standards are given for the ordinary batters and doughs. It is desirable to judge carefully every product prepared in order to know whether accepted standards are attained. Score cards for judging are given on pages 137–144.

General Information about Ingredients Used in Batters and Doughs

Leavening Agents

Leavening of products may result from the incorporation in the mixture of *air*, which expands when heat is applied; from *steam*, which is produced from the liquid ingredients when a high temperature is applied especially at the beginning of the baking process; or from *carbon dioxide*, which results from various chemical reactions, depending upon the leavening agent used.

The steam from a liquid will leaven a quantity of flour equivalent to the quantity of liquid used, or steam from 1 cup of liquid leavens 1 cup of flour. Any flour in a recipe beyond the quantity affected by the steam must be leavened by other means.

Egg albumin adds in leavening because of the thin elastic membrane of its cells. Air bubbles are entangled and held until heat coagulates the albumin.

For batters and quick breads, baking powder is the most widely used leavening agent. Sometimes it is used alone, and sometimes it supplements the soda. It leavens in proportion to the carbon dioxide produced, and if it is to be regarded as satisfactory it must yield at least 12% of available carbon dioxide. Baking powder is composed of 2 parts of some acid-

TABLE 14

STANDARDS FOR SOME BATTER AND DOUGH PRODUCTS

Product	Appearance	Crust	Texture	Flavor
Baking powder biscuit	Golden brown, fairly smooth and level top; cylindrical shape; uniform size	Crisp, tender	Slightly moist, tender, light, flaky; medium fine grain, creamy white and free from spots	Pleasing
Bread—baking powder loaf with fruit or nuts	Golden brown; slightly rounded top	Thin, tender	Fine grain, does not crumble when cut; fairly moist	Distinct flavor of fruit or nuts
Rolls—yeast	Golden brown; uniform size and shape	Thin, tender and crisp	Finer, less resilient than bread, light	Richer than bread
Bread—yeast	Even golden brown; smooth, well rounded, almost symmetrical top; no streaks visible	Thin, tender	Creamy white crumb; uniform fine grain; resilient; light; slightly moist	Slightly sweet and nutty
Cake—butter	Uniform golden brown; flat or slightly rounded top; even thickness	Thin, tender; not sugary	Fine grain; velvety, resilient, light and fluffy, very tender	Delicate, sweet, well blended
Cake—butterless	Even delicate brown; flat or slightly rounded top; slightly rough surface like macaroons	Thin, tender; not sugary	Fine grain; very light, very tender, slightly moist	Pleasing, delicate
Griddle cakes	Evenly browned on both sides; fairly regular shape; uniform thickness	Smooth, tender	Light, tender; moderately moist, not sticky; even grained	Pleasing
Muffins	Golden brown; definitely rounded, pebbled top; symmetrical	Crisp, tender	Medium fine grain, fairly uniform holes; tender; light, slightly moist; creamy white, free from yellow spots	Pleasing
Pastry	Delicate brown; rough with small blisters		Flaky and light; tender, crisp, dry	Pleasing
Popovers	Golden brown; irregular and peaked top	Crisp, tender	Hollow shell with a few thin partitions; slightly moist interior	Mild, well blended
Waffles	Uniform golden brown; regular shape	Crisp, tender	Light, slightly moist soft crumb	Pleasing

reacting material, 1 part of a carbonate, generally sodium bicarbonate, and 1 part of filler in the form of flour or starch, which tends to absorb moisture from the air and to keep the acid and alkali constituents from becoming moist and starting to work.

Baking powders are classified according to their acid constituents. The following types are on the market:

1. Tartrate: the acid salt of tartaric acid.
2. Phosphate: the mono-acid-calcium phosphate and the dicalcium phosphate.
3. Sulphate: the sodium aluminum sulphate.
4. Combination of any of the foregoing, the usual forms being sodium aluminum sulphate and calcium acid phosphate.

Reactions of Leavening Agents

Tartrate:

$$KH\,(C_4H_4O_6) + NaH\,CO_3 \rightarrow \underset{\text{Rochelle salts}}{NaK\,(C_4H_4O_6)} + CO_2 + H_2O$$

Tartaric acid:

$$H_2\,(C_4H_4O_6) + 2\,Na\,H\,CO_3 \rightarrow \underset{\text{Sodium tartrate}}{Na_2\,(C_4H_4O_6)} + 2\,CO_2 + 2\,H_2O$$

Phosphate:

$$Ca\,H_4\,(PO_4)_2 + Na\,H\,CO_3 \rightarrow \underset{\text{Calcium acid phosphate (Sodium acid phosphate)}}{Ca\,H\,PO_4} + Na\,H_2\,PO_4 + CO_2 + H_2O$$

Aluminum sulphate:

$$Na_2\,SO_4 \cdot Al_2\,(SO_4)_3 + 6\,Na\,H\,CO_3 + 6\,H_2O = \underset{\text{Aluminum hydroxide}}{2\,Al\,(OH)_3} + \underset{\text{Sodium sulphate}}{4\,Na_2\,SO_4} + 6\,H_2O + 6\,CO_2$$

The ideal baking powder has the following characteristics: (1) gives most gas for least volume and weight of powder, (2) gives gas slowly in the cold and at a fairly rapid rate in the early stages of baking, (3) leaves a tasteless and harmless residue, (4) keeps well, and (5) is low in cost.

Use of Sodium Bicarbonate (Soda)

Soda is used to neutralize acid foods, and as the acid is neutralized carbon dioxide is formed which aids in leavening. When substituting soda for baking powder in a recipe, use 1 teaspoon of soda for 4 teaspoons of baking powder.

Flour

Flours are made from the common grains, wheat, rye, barley, corn, and rice, wheat flour being the most popular.

1. *Wheat flour.*[1]
   a. *Classes of wheat used for flour.* There are five main classes of wheat, some of which are more suitable for one type of flour, some for another, and some for several types. A fine or coarse flour or a "weak" or "strong" one may be produced from any given class by different milling processes, determined by the ultimate use of the flour. The five main classes of wheat and the common types of flour milled from them are:
      (1) White, used for bread, cake, pastry, and other flours, according to the type and origin of the wheat.
      (2) Hard red spring, used chiefly for the manufacture of bread flours.
      (3) Hard red winter, used chiefly for the manufacture of bread flours.

[1] *Terminology Used in Food Preparation.* A. H. E. A.

(4) Soft red winter, used chiefly for the manufacture of biscuit, cake, and pastry flours and to a very limited extent for bread flours.

(5) Durum, used for the manufacture of semolina (the purified middlings of durum wheat), which in turn is converted into superior macaroni, spaghetti, and other edible pastes.

b. *Types of wheat flours.*

(1) *Whole wheat* or *entire wheat* or *graham flour* "is the product made by grinding wheat, and contains, in their natural proportions, all of the constituents of the cleaned grain."

(2) *Flour*, when the term is used unqualified, or *wheat* or *white flour* is the finely ground product obtained in the commercial milling of wheat and consists essentially of the starch and gluten of the endosperm. It is marketed under the following names:

(a) *Straight flour* (100% flour) is a milling term indicating that all the bolted meal is recovered from any class of wheat after removal of the feeds. This type, not generally on the market, is the original flour from which all commercial flours are derived.

(b) *Patent flour* is a term indicating the more refined portion of the wheat meal (from any class of wheat) from which all or a portion of the "clears" have been removed. The terms "short" or "extra fancy patent" are used by some mills to indicate a low percentage of extraction and, therefore, a more highly refined flour. Other things being equal, patent flour usually has less ash, fiber, and fat than clear flour and is also whiter.

(c) *Clear flour* is a term indicating the less refined, bolted portion of the wheat meal (from any class of wheat) recovered in the manufacture of patent flour. (This statement does not imply that clear flours are less desirable for certain types of bread production than more refined flours.)

(d) *Blended flour* is a term meaning that two or more flours of the same type but of different quality have been mixed.

(e) *Bread flour* (white) is a term indicating a "strong" flour which usually contains more gluten and less starch than either cake or pastry flour. Bread flour has the capacity to make loaves of good volume, texture, and grain. (In certain sections of the country a suitable soft-wheat flour is used for bread baking.)

(f) *All-purpose*, *general-purpose*, and *family flour* are synonymous terms for a flour containing a moderate amount of gluten. Flour of this type ranks between typical bread and cake flours in gluten content and strength. These flours are usually made by blending wheats, or flours, selected to produce characteristics suitable for most kinds of baking.

(g) *Cake and pastry flour* are terms indicating flours milled from soft wheat usually containing a lower percentage of gluten than bread flour. Cake and pastry flours differ slightly in their baking qualities, and both differ in this respect from bread flour.

(h) A *self-rising flour* is a flour blended with salt, sodium bicarbonate, and an acid ingredient.

2. *Other grain products.*

a. *Buckwheat flour* is the finely ground product obtained by bolting buckwheat meal.

b. *Corn meal* is made by grinding corn coarsely.

(1) "Old process" or "water-ground" corn meal is usually made from white corn. The skin and germ are not removed before grinding; and, after bolting, some of the skin and a large proportion of the germ remain in the meal.

(2) "New process" corn meal is made from both white and yellow corn. The skin and germ are largely, but not entirely, removed in milling.

c. *Rye flour* is the finely ground product obtained by bolting rye meal.

d. *Soy bean flour* from soy beans is coming into general use commercially.

Composition of Wheat Flours

The composition of wheat flours is given in Table 15.

TABLE 15

APPROXIMATE COMPOSITION OF WHEAT FLOURS[1]

	Carbohydrate % (mostly starch)	Protein %	Fat %	Water %	Mineral matter % (ash)
Patent hard wheat flour.....	74.6	10.8	1.0	13.2	0.4
Patent soft wheat flour.....	76.7	8.7	1.1	13.2	0.3
Graham flour (wheat meal)....	70.9	12.3	1.8	13.2	1.8

[1] U. S. D. A. Farmers' Bul. 1450.

White flour contains carbohydrates, proteins, mineral salts, cellulose, fat, moisture, and, in addition to these, enzymes and pigments. The carbohydrate is mostly starch, 75 to 80%. There are only small quantities of sugars: maltose, sucrose, and glucose. Gluten is the term used for the principal protein fraction of the flour. Whether this is one protein or two or more is a point of controversy. The fat, cellulose, and mineral contents are low since they are removed with the germ in milling. The most important enzymes are the diastases, amylases, and proteinases. Flour contains the pigments carotene, xanthophyll, and flavones.

Flour Strength

The baker defines a strong flour as one which has a capacity to make bread loaves of good volume and texture. Flours are called strong if they have a comparatively large quantity and good quality of protein and weak if their protein is small in quantity and poor in quality.

Shortening

"Shortening is any fat or fixed oil used as an ingredient in baked products."[1] That material has the greatest shortening power which, when baked under a standard condition, gives the product a minimum breaking strength and a minimum crushing strength.[2]

Rôle of fat in batters and doughs.

The fundamental effect of shortening in a batter or dough is to make the dough short and less sticky and to produce a more tender mass which can easily be broken; beyond this, the action of each shortening differs considerably from the action of others.

Since shortening is neither miscible nor soluble in water, the layers of fat prevent par-

[1] PLATT, W., and FLEMING, R. *The Action of Shortening in the Light of the Newer Theories of Surface Phenomena.* J. Ind. and Eng. Chem. **15**: 390–394, 1923.

[2] CLARK, C. *Shortening—Its Definition and Measurement.* J. Ind. and Eng. Chem. **13**: 797–799, 1921.

ticles of gluten from cohering. In like manner the shortening even penetrates between the starch grains and breaks up what would otherwise be a continuous mass.

Many factors are involved in the action of shortening. A dough is a complex mixture of colloids and crystalloids, partly in solution and partly in colloidal dispersion. The action of mixing brings about a coating of the particles of flour with fat. The condition is further modified in baking. No one property is responsible for the shortening power of fat but it is true that the fat having the greatest shortening power is the one that can cover the greatest surface of flour particles.

"The factors which affect the area of flour covered are (1) manipulation, (2) temperature, (3) ingredients used and their concentration, (4) consistency of fat or oil when added and its degree of unsaturation and (5) the concentration of the fat."[1]

Technical Vocabulary Used in Batters and Doughs

batter
bicarbonate of soda
carbonate
carotinoids
cohesion
colloidal
creaming
cream of tartar
diastase
dough
durum
elasticity
enzyme
folding
gluten
hydration capacity
hygroscopic
ionization
kneading
lactic acid
leavening agent
maltase
maltose
margarine
neutralization
phosphate
pigments
plasticity
potassium acid tartrate
protease
Rochelle salts
shortening power
sodium aluminum sulphate
sodium lactate
sodium tartrate
sponge
stirring
strong flour
syneresis
tartrate
tenacity
texture
volume
zymase

Some Approved Practices in the Preparation of Batters and Doughs

1. Use some bread or all-purpose flour with flours of low gluten content, as in corn meal, bran, and whole wheat products.
2. Use judgment in mixing batters and doughs in order that standard for the product may be attained.
3. Know the consistencies of standard batter and dough products.
4. Add flour with starch content, as wheat flour, when corn meal and bran are used.
5. Choose baking powder for batters and doughs according to the consistency and length of standing period before cooking.

[1] Lowe, B. *Experimental Cookery*, Second Edition, p. 565, 1937. Published by John Wiley & Sons, Inc. Reprinted by permission.

6. Maintain a definite relation between the liquids and solids to secure a standard product for the series represented.
7. Consider all liquid when determining the amount of leavening to be used to produce a standard batter and dough product.
8. In cake making, cream the butter and sugar thoroughly and use less baking powder.
9. Avoid excess of sugar in yeast doughs.
10. When whole wheat flour is used, increase the amount of baking powder.
11. Keep a definite relation between sugar and gluten in cake making.
12. Cream sugar and shortening thoroughly when preparing cake.
13. When making a cake add a portion of the dry ingredients before adding the liquid.
14. Products made with honey as a substitute for sugar should have the liquid correspondingly reduced.
15. Products in which milk is used as a liquid brown readily.
16. Use fine-grained sugar in making cakes.
17. Use honey in fruit cake in order to have a moist product.
18. Decrease the liquid when substituting molasses in a recipe.
19. Use cream of tartar when making angel cake to produce a white cake.
20. Use eggs a few days old when preparing angel cake.
21. Whip eggs at room temperature.
22. Bake soft meringue as short a time as possible.
23. In preparing angel cake, a small amount of water may be added to the whites if they are very viscous.
24. When making butter cake add a part of the sugar to the beaten egg white.
25. When making angel cake add some of the sugar to the beaten egg white.
26. Add a small amount of salt while beating egg whites.
27. Beat egg whites sufficiently for the use intended, but not beyond this point.
28. In the mixing of each type of batter and dough, a definite method of incorporation of fat must be followed in order to secure a desirable texture. Example: in pastry cut in the fat.
29. Rich cakes can be kept satisfactorily longer than those containing less fat.

Add other approved practices.

List each of the approved practices in the preparation of batters and doughs in the blank space opposite the fact or principle which affords a scientific basis for the practice.

Scientific Facts and Principles	Approved Practices
	Flour
1. Gluten is elastic; it can be stretched to form a framework.	
2. Gluten absorbs water and forms an elastic colloidal gel which stretches under tension of a gas.	
3. Acid salts affect the rate of hydration of gluten and the total quantity of water absorbed.	
4. Gluten is hardened by heat.	
5. Beating and kneading develop gluten.	

Scientific Facts and Principles	Approved Practices
6. The development of gluten is hindered by the addition of sugar.	
7. Starch, which swells and gelatinizes by absorption of water, acts as a binder for other ingredients.	
8. A part of the starch of flour is gelatinized when a batter or dough is baked.	
9. The moisture content of white flour varies from 13% to 15%. Freshly milled flours have a high percentage of moisture. It may be as high as 14.5%. The greater the percentage of moisture in flour, the less will be its absorption.	Know the consistencies of typical batters and doughs for standard products. The quantity of flour will vary according to the moisture content.
10. Pigments of flour are cream colored in a slightly alkaline medium, white in an acid medium.	Use cream of tartar when making angel cake.
	Liquids
11. The quantity of water which a colloid can absorb is limited.	

Scientific Facts and Principles	Approved Practices
12. Steam acts as a leavening agent; when water forms steam the volume increases about 1800 times.	
13. Molasses is approximately 25% water.	
14. Honey is approximately 20% water.	
15. In each batter and dough product there must be some optimum relation between the fat and gluten or other protein.	*Fats*
16. Fat helps to retain moisture in baked products.	A rich cake keeps longer than one with less fat.
17. A fat which emulsifies easily with a liquid helps to give a better distribution of all ingredients in a product.	

Scientific Facts and Principles	Approved Practices
18. Fat absorption in frying is increased by: a. Too soft a dough. b. Increased shortening. c. Increased sugar. d. A rough surface. e. Too much leavening.	
	Sugars
19. The proper balance of sugar to the other ingredients gives a product of such texture, grain, and color that it is standard for the series it represents.	
20. Too high a proportion of sugar to gluten in batters and doughs influences the spreading power of cookies.	
21. Creaming sugar and fat helps to start and retain a good emulsion.	
22. A fine-grained sugar gives a better emulsion than coarse sugar, thus producing a finer grain.	
23. High temperatures of baking, or baking for too long a time, caramelizes sugars.	

Scientific Facts and Principles	Approved Practices
24. Lactose caramelizes more quickly than sucrose.	
25. Honey, which contains an average of 75% invert sugar, is hygroscopic.	
26. Steam leavens a quantity of flour equivalent to the quantity of liquid used, steam from 1 c. liquid leavening 1 c. flour. Any flour in a recipe beyond the quantity affected by the steam must be leavened by other means.	*Leavening* *Steam* All the liquid must be considered when figuring the leavening for batters and doughs.
27. Air may be incorporated by entangling air in beaten egg whites or by certain manipulative processes: a. Beating. b. Folding. c. Kneading. d. Mixing.	*Air*
28. Carbon dioxide is easily released from baking soda by an acid.	*Carbon Dioxide*

Scientific Facts and Principles	Approved Practices
29. Sodium bicarbonate (soda) may be used to neutralize the acid of foods.	½ t. soda neutralizes 1 c. well-clabbered milk or 1 c. molasses; ⅕ t. soda neutralizes 1 sq. chocolate.
30. In addition to furnishing carbon dioxide by neutralization of its acid, the liquid of the material also furnishes a source of steam for leavening purposes.	
31. Chemical action in baking powder is hastened by moisture or heat or both, depending upon the acid ingredient. The following indicates the speed of the reaction in decreasing order: a. Acid calcium phosphate. b. Cream of tartar. c. Sodium pyrophosphate. d. Sodium aluminum sulphate.	
32. The standard proportion of baking powder used may be affected by: a. Consistency of batter. b. Method of cooking (especially surface of product exposed). c. Manipulation. d. Kind of flour. e. Kind of baking powder. f. Altitude.	
33. Excess baking soda or excess alkalinity in a product increases the spreading power, gives smoothness to the bottom, and hastens the browning of the product.	

Scientific Facts and Principles	Approved Practices
34. The carbon dioxide from 1 part of soda is equivalent to the carbon dioxide from 4 parts of baking powder.	
35. Carbon dioxide may be formed by the fermentation process, by fermentation of sugars by yeast. $C_6H_{12}O_6 \longrightarrow 2\ CO_2 + 2\ C_2H_5OH$	
36. The quantity of carbon dioxide produced by the action of yeast on sugar and its availability within a given time are dependent upon the kind and quantity of yeast, the quantity of sugar, and the temperature.	
37. Conditions favorable for yeast growth are: a. Warmth (77° to 95°F.; 25° to 35°C.). b. Moisture. c. Food (simple sugars, nitrogenous compounds, soluble salts of potassium, calcium, magnesium, and phosphorus and oxygen).	*Yeasts*
38. Low temperature, 50°F. or 10°C., checks yeast growth.	

Scientific Facts and Principles	Approved Practices
39. High temperatures check yeast growth (over 95°F. or 35°C.).	
40. The optimum temperature for bread making is 82°F. (28°C.) to 86°F. (30°C.).	
41. Fermentation continued too long will convert the alcohol into lactic acid and a small quantity of acetic acid.	
42. Heat causes dissipation of alcohol.	
43. Within limits, the more yeast used in a batter or dough the shorter time is required for fermentation.	
44. Salt inhibits the growth of the yeast plant.	

Scientific Facts and Principles	Approved Practices
45. The whipping quality of eggs is influenced by: a. Age. b. Consistency of the whites. c. Temperature. d. Utensils used.	*Eggs*
46. Too little beating of egg white gives a foam having too little rigidity to support other ingredients. Overbeating decreases the capacity of egg white to hold air and causes the white to become dry.	Beat egg white carefully to the stage best for each particular purpose.
47. Surface tension of albumins is lowered with increased temperature.	Eggs at room temperature whip better than very cold ones.
48. Salt lowers the surface tension of egg protein at the air and liquid interface, hence a slight stiffening.	The addition of a small amount of salt to egg white while beating aids in increasing foaming and stiffness.
49. The addition of sugar in limited quantities increases the ability of egg white to hold air.	When making angel cake add some of the sugar to the beaten egg before adding other ingredients.
50. In limited amounts water increases the extensibility of egg whites.	

Scientific Facts and Principles	Approved Practices
51. Acid aids in the dispersion of a colloid, increasing the surface film and the swelling power, thus giving more elasticity.	Add cream of tartar to egg whites in making angel food cakes to make them more tender.
52. Egg albumin is a good emulsifying agent.	Eggs help to give a fine texture in cakes.
53. The high percentage of fat in egg yolk gives it less aerating power than white.	
54. Egg albumin is toughened by cooking at too high a temperature.	
55. Egg albumin is toughened by cooking too long a time.	Bake soft meringue as short a time as possible.

Suggested Readings

Batters and Doughs

Goldthwaite, N. E. *Principles of Bread-Making.* Col. Agr. Exp. Sta. Bull. 344. 1929.
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Home Made Bread, Cake, and Pastry. Farmers' Bulletin 1775. U. S. D. A., 1937.
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Chapter VIII

CANDY AND SUGARS

The chief constituent in candy is sugar, which furnishes energy and body fat. Any other nutritive value which candies contain depends upon the kind and amount of material added in the preparation.

Questions on Sugar Cookery

1. Compare the crystals formed by spontaneous crystallization and those brought about by agitation.
2. What is the difference in the use of cream of tartar and corn syrup or glucose in preventing crystallization of candies?
3. Name the "foreign materials" which may be added to cream candies. What is their function?
4. How is it possible for two persons using the same recipe and presumably working under the same conditions to secure quite different fondant results?
5. Account for the texture of amorphous candies.
6. What is caramel? What properties make it valuable for cookery?
7. Give the source of the following: brown sugar; powdered sugar; molasses; corn syrup; honey; corn sugar.
8. Why need not fudge be cooled to as low a temperature as fondant before beating?
9. Suggest the best method for storing each type of candy. Explain.
10. What change occurs in sucrose when cream of tarter is added?

General Information about Candies and Sugar Cookery

Classification of Candy

Candies may be classified or grouped from their texture or the physical form of sugar found in them.

Sugar in uncrystallized form (amorphous).
  Brittles: made from melted sugar (dry heat).
  Hard candies: brittle taffy and butterscotch.
  Soft candies: caramels, chewy taffies, and pull candies.
Sugar in crystallized form.
  Cream candies or candies having small imperceptible crystals: fondant, fudge.
  Hard crystal candies with crystals readily apparent: rock candy.
Special texture.
  This is produced by the addition of such material as gum arabic, gelatin, or egg white: sea-foam or divinity, gum drops, marshmallows, Turkish paste.

Table 16 gives the temperatures and tests for syrup and candies which will give standard desired.

TABLE 16

TEMPERATURES AND TESTS FOR SYRUP AND CANDIES [1]

Product	Temperature[2] of Syrup at Sea Level (indicating concentration of sugar desired)		Stage of Concentration Desired	Behavior at Stage Desired
	Degrees F.	Degrees C.		
Syrup	230–234	110–112	Thread	The syrup spins a 2-inch thread when dropped from fork or spoon.
Fondant, Fudge, Penuchi	234–240	112–115	Soft ball	The syrup when dropped into very cold water forms a soft ball which flattens on removal.
Caramels	244–248	118–120	Firm ball	The syrup when dropped into very cold water forms a firm ball which does not flatten on removal.
Divinity, Marshmallows, Nougat, Popcorn balls, Salt-water taffy	250–265	121–130	Hard ball	The syrup when dropped into very cold water forms a ball which is hard enough to hold its shape, yet plastic.
Butterscotch, Taffies	270–290	132–143	Soft crack	The syrup when dropped into very cold water separates into threads which are hard but not brittle.
Brittle, Glacé	300–310	149–154	Hard crack	The syrup when dropped into very cold water separates into threads which are hard and brittle.
Barley sugar	320	160	Clear liquid	The sugar liquefies.
Caramel	338	170	Brown liquid	The melted sugar becomes brown.

[1] *Terminology Used in Food Preparation.* A. H. E. A.

[2] The temperature for candy syrups should be taken near the surface as the temperature near the bottom is hotter than the true boiling point of the syrup.

Thread Test for Syrup.—Drop the syrup from a spoon or a fork so that it will spin a thread, and note the length of the thread.

Cold Water Test.—Drop about ½ teaspoon of syrup into ½ cup of very cold water. Shape with the fingers into balls, which will vary in hardness according to the concentration of the syrup, or note how the syrup separates into threads when it strikes the water.

Sugars

The most important sugars from the standpoint of food values are the *disaccharides* and the *monosaccharides*. The former have twelve carbon atoms and the latter have six carbon atoms in their chemical structure. The common disaccharides are sucrose (beet or cane sugar), lactose (milk sugar), and maltose (malt sugar). Only two monosaccharides, dextrose (glucose) and levulose (fructose), are common. Commercial sucrose is 99.85% pure carbohydrate; the other forms of sugar contain certain other constituents in varying amounts.

Sugars vary in their relative sweetness, as indicated in Table 17.

TABLE 17

Relative Sweetness of Different Sugars

Kind of Sugar	Approximate Sweetness*
Sucrose	100 %
Glucose	74 %
Lactose	16 %
Levulose	173 %
Maltose	32.5%

* Willaman, J. J., Wahlin, C. S., Biester, A. *The Relative Sweetness of Invert Sugar.* Am. Journ. Physiol. 73:397–400. 1925.

The different forms in which sugars appear on the market are:[1]

"*Sugars.* The term sugar when used unqualified refers to refined sucrose in the granulated form, made from either sugar cane or sugar beets. Market grades of cane and beet sugar are based on the degree of refinement and the size of the crystals. When the kind of sugar is not specified granulated sugar is meant.

"1. *Brown sugar* is an intermediary product produced in the refining of cane sugar from raw sugar. Market grades are based upon the color and are designated by numbers ranging from No. 8 for a very light sugar to No. 15 for a very dark one. The two grades commonly found in retail food markets are:

"(a) Light brown sugar (sometimes known as yellow sugar), which represents about a No. 8 to a No. 10 sugar, and

"(b) Dark brown sugar, which represents a No. 11 or darker sugar.

[1] *Terminology Used in Food Preparation.* A. H. E. A.

"2. *White sugar* is graded according to the size of the particles:
"(a) Granulated sugar
"(1) Standard granulated sugar consists of the medium-sized crystals most commonly used in cookery.
"(2) Berry or fruit sugar (sometimes known as fruit powdered sugar) consists of small crystals, used mostly when rapidity of solution is desired, as in iced beverages or on raw fruits.
"(b) Powdered sugar is prepared by grinding coarse granulated sugar. Two grades, according to size of particles, are commonly found on the retail market.
"(1) Powdered sugar (XX), consisting of the coarser particles, is used largely for serving with fruits and cold beverages. It is often mixed with a small amount of cornstarch to prevent caking in moist air.
"(2) Confectioners' sugar (XXXX), consisting of finer particles, is used chiefly in meringues and uncooked icings. It is usually mixed with cornstarch (less often with a small amount of calcium phosphate) to prevent caking.
"(c) Special forms of sugar
"(1) Cube or tablet sugar is made by pressing wet crystals of granulated sugar into molds and subsequently cutting the block into pieces of the desired size and shape.
"(2) Coarse sugar consists of large crystals, often colored for decorative purposes in cookery.
"3. *Other sugars*
"(a) Maple sugar consists of the crystallized solids of maple syrup.
"(b) Corn sugar is crystallized dextrose, obtained by the hydrolysis of the starch of corn. It is usually marketed in the hydrate form which contains one molecule of water of crystallization."

Different forms of syrups are:

Molasses is the residue left after the extraction of the crystalline sugar. The second and third grades are obtained through the second and third extractions.

Corn syrup or commercial glucose is prepared by hydrolyzing cornstarch with hydrochloric acid. Its composition is water (about 15%), glucose (about 35%), dextrin (from 30 to 45%), maltose (from 5 to 20%), and ash (about 0.5%).

Honey contains fructose and glucose, with more of the former than of the latter. The average composition is water (about 18%), sucrose (2%), fructose (40%), glucose (35%), dextrin (2%), and a very small percentage of ash, with some still unidentified material.

Hydrolysis of Sucrose

When sucrose is hydrolyzed, one molecule of sucrose unites with water to form one molecule each of two simple sugars, glucose and fructose. This process is often spoken of as inversion because the optical rotary power of the sugar is changed after hydrolysis. The following formula illustrates the hydrolysis of sucrose:

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \longrightarrow \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

The quantity of sugar hydrolyzed in boiled sugar solutions depends upon (1) the concentration of the acid, (2) the temperature of cooking, (3) the time of cooking, (4) the proportion of liquid to sugar, and (5) the size and shape of the kettle.

Technical Vocabulary for Candies and Sugars

amorphous
brittles
caramel
conversion
crystal
crystallize
dextrose
disaccharide
fondant
fructose
glucose
hydrolysis
inversion
invert sugar
lactose
levulose
maltose
monosaccharide
non-crystalline
nucleus
saturated
supersaturated

Some Approved Practices in Sugar Cookery

1. The most accurate test for doneness in sugar cookery is the thermometer test of boiling temperature.
2. Soak and wash dishes used in sugar cookery in hot water.
3. Regulate by temperature the color and flavor of caramel desired.
4. Caramel can be made in large quantities and kept indefinitely.
5. Boil caramel at least ten minutes.
6. Use hot liquid for dissolving caramelized mixtures.
7. Soak and wash pans used for caramelization in hot water.
8. Caramel may be used to color gravies and soups.
9. Brown sugar causes milk to curdle.
10. Measure hydrolyzing agent carefully.
11. Do not cook fondant too slowly nor too long.
12. Cool fondant slowly.
13. Cream, butter, or corn syrup may be added to fudge.
14. Fudge may be beaten at a higher temperature than fondant.
15. Syrup, cream of tartar, or acids may be added to fondant.
16. Do not beat cream candies while they are warm.
17. Moist atmosphere may prevent candies from creaming.

Add other approved practices.

List the approved practices for sugar cookery in the blank space opposite the fact or principle which forms a scientific basis for the practice.

Scientific Facts and Principles	Approved Practices
1. Sucrose is soluble in water, the rate and total solubility increasing with rise of temperature.	Soak dishes used for sugar cookery in hot water.
2. Boiling sugar solutions evaporates water and concentrates the sugar solution.	
3. Boiling temperatures are a measure of the concentration of a syrup.	The most accurate test for doneness in sugar cookery is the thermometer test of boiling temperature.
4. Length of time necessary to bring candies to a desired consistency depends upon: Proportion of liquid used. Intensity of heat. Rapidity of evaporation.	
5. Sucrose melts at 320°F. (160°C.). When heated above its melting point it begins to decompose with the evolution of water. Between 338°F. (170°C.) and 374°F. (190°C.), a brownish substance known as caramel is formed.	

Scientific Facts and Principles	Approved Practices
6. Caramel consists of a mixture of decomposition products, among them appreciable amounts of formic acid. Small amounts of formic acid inhibit bacterial growth.	
7. Caramelization of sugars is accentuated by alkalis.	
8. Furfural is formed in the caramelization of all common sugars. It is expelled if boiled with water for 10 to 15 minutes. A small amount of volatile acrolein is also formed.	
9. Caramel dissolves slowly in cold water, but very rapidly in hot water.	
10. Caramel is non-crystalline.	
11. Caramel is less sweet than sucrose.	Caramel may be used to color gravies or soups.

Scientific Facts and Principles	Approved Practices
12. Dextrose caramelizes at a lower temperature than sucrose.	
13. Brown sugar contains small quantities of acid, invert sugar, various impurities, and considerable moisture.	
14. Sucrose is readily hydrolyzed in the presence of heat and acid to fructose and dextrose. The consistency of fondants and soft candies is dependent upon the amount of hydrolysis taking place.	
15. The higher the temperature to which a solution is cooked, the greater the amount of hydrolysis.	
16. If a sugar solution is cooled slowly, sucrose will hydrolyze more than if cooled rapidly.	
17. Hydrolysis of too much sucrose prevents the creaming of fondant.	

Scientific Facts and Principles	Approved Practices
18. Fondant undergoes ripening and becomes more pliable after 24 hours.	
19. A temperature of 95°F. (35°C.) to 104°F. (40°C.) is the optimum temperature for fondant crystallization.	
20. Crystallization is hastened by the presence of nuclei, preferably of the crystals to be formed.	
21. Agitation of a concentrated sugar solution favors crystallization, and the warmer the mixture the larger the crystals.	
22. The addition of some foreign substance to produce small crystals in candies or frostings will help, or the more foreign materials added the less is the tendency to form large crystals.	Cream, butter, or corn syrup are used in making fudge. Syrup, cream of tartar, or acids are used in making fondant.
23. The temperature of a cooked sugar solution at the time of beating is the largest factor in controlling size of crystals.	

Scientific Facts and Principles	Approved Practices
24. Levulose does not crystallize easily.	
25. Levulose is very soluble in water.	
26. Under most conditions glucose can take up moisture from the atmosphere to approximately 15% of its weight.	
27. Lactose is a granular powder which is slightly soluble in cold water, but more soluble in hot water.	
28. Sucrose is much sweeter than lactose.	
29. Lactose caramelizes easily.	

Scientific Facts and Principles	Approved Practices
30. Lactose is converted into lactic acid in the presence of certain bacteria.	

Suggested Readings

Candy and Sugars

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Chapter IX

FROZEN MIXTURES

Frozen mixtures contribute variety to the day's meals, and those using milk, cream, and eggs are highly nutritious. The ices and sherbets are good bases for the introduction of fruit juices and pulp. In all these mixtures the sugar furnishes energy.

Questions on Frozen Mixtures

1. Which is more desirable for making frozen mixtures—fresh cream, or cream which has been aged a day?
2. What is the advantage in cooking a syrup of the sugar and water in making sherbets?
3. Should the flavor and color of the "mix" be more or less intense than desired in the frozen products?
4. When should fruits and nuts be added to frozen products?
5. Why is more salt required for some frozen mixtures than for others?
6. In what quantities and in what manner should salt be added to the ice?
7. How full may a freezer be filled with the "mix" before freezing?
8. Why should custards be cooled before being put into the freezer?
9. What causes a greasy texture in frozen mixtures?
10. How may a fine texture be secured in frozen products?
11. What are the advantages of ripening frozen mixtures?
12. What are the disadvantages of prolonged stirring and of rehandling frozen mixtures?
13. Why do home-made desserts often melt more quickly than some commercial products?
14. What types of recipes are well adapted to a "still-freeze"?
15. What is the function of salt in the freezing mixture when freezing desserts?

General Information on Frozen Mixtures

The following are the common frozen mixtures:

Frappé is an ice or a sweetened diluted fruit juice frozen to a mushy consistency.

Ice cream is a frozen product made from cream, sugar, and flavoring.

Philadelphia (plain): cream, sweetened and flavored.

French: a custard foundation, cream and flavoring.

Neapolitan: three or more ice creams, sherbets, or ices of different flavors and colors molded into a stratified brick.

Ices are made from fruit juice diluted with water, sweetened and frozen, and having, as a rule, a characteristic granular texture.

Mousse is made from whipped cream, sugar, and flavoring, and is frozen without stirring. Gelatin is often added to stabilize the mixture. It is a "still-freeze."

Parfait is a frozen dessert made of whipped cream, eggs cooked with syrup, and flavoring. It is frozen without stirring.

Sherbets are made from the same mixture as ices with the addition of egg white and occasionally gelatin. Milk may replace the water.

Certain accepted terms are used in connection with frozen mixtures. *Mix* is the term applied to the mixture to be frozen. *Freezing mixture* is the term applied to the ice and salt used to freeze the mix. *Stabilizers* are substances added to frozen mixtures to improve the body and texture by preventing formation of large ice crystals. Eggs, gelatin, and homogenized milk are common stabilizers. *Fillers* are substances added to ice cream to replace fat and milk solids. They may serve the purpose of a stabilizer. Starches (cornstarch, flour, arrowroot), eggs, and excess of gelatin are common fillers. *Swell*, or *overrun*, is the volume of ice cream obtained over the volume of the mix before freezing. *Homogenization* is the process whereby an emulsion is made more completely dispersed. The fat particles are greatly increased in numbers. The process thickens the cream or milk and prevents the separation of cream or fat on standing. Evaporated milk is homogenized. Homogenization of cream increases viscosity and freezing and whipping qualities.

Technical Vocabulary on Frozen Mixtures

fillers	mousse
freezing mixture	overrun
homogenization	sherbets
ices	stabilizers
mix	swell

Some Approved Practices in the Preparation of Frozen Products

1. Use egg, gelatin, or evaporated milk as a stabilizer.
2. Use cream which has been aged in preparing ice cream.
3. Add a larger quantity of flavoring to frozen custards than to unfrozen.
4. Give mixtures to be frozen a more intense color than is desired in the finished product.
5. Do not add fruit or nuts to ice cream until it has begun to thicken.
6. Turn freezer rapidly after mix has reached the freezing point.
7. Freeze unstabilized mixes harder than those with stabilizers.
8. Do not add salt to ice until the mixture is in the freezer and ready for freezing.
9. Use 8 to 12 parts of ice to 1 part of salt, by volume, when freezing ice cream.
10. Allow ice cream to ripen after it is frozen.
11. Fill freezer only two-thirds full.
12. Allow more room for expansion of ices than for an equivalent volume of ice cream.
13. Do not add too large amounts of solids to mixes to be frozen.
14. Do not use too much salt in proportion to ice.
15. If mixture is soft, add more salt when packing.
16. To prepare a frozen dessert use salt with ice for a freezing mixture.

Add other approved practices.

List each of the approved practices in the preparation of frozen products in the blank space opposite the fact or principle which affords a scientific basis for the practice.

Scientific Facts and Principles	Approved Practices
1. Viscosity of cream holds the air incorporated during the freezing process and is largely responsible for the body and yield of ice cream.	
2. Viscosity is increased by fillers and stabilizers.	Use egg, gelatin, or evaporated milk as stabilizer.
3. Viscosity is increased by aging at a low temperature.	
4. Viscosity is decreased by pasteurization.	
5. Viscosity is increased by homogenization.	

Scientific Facts and Principles	Approved Practices
6. With a given viscosity the amount of air beaten into an ice cream mixture is dependent upon speed of turning and upon the temperature of the surrounding mixture.	
7. Low temperature deadens the taste buds.	
8. Incorporation of air by whipping causes refraction of light in frozen mixtures, thus diminishing the intensity of the color.	
9. Mixes which contain no stabilizers melt rapidly.	
10. Dense ingredients tend to sink to the bottom of the container.	
11. Too large a percentage of solids other than fats will cause "sandiness."	

Scientific Facts and Principles	Approved Practices
12. Any body in changing from a solid to a liquid state absorbs heat.	
13. Salt hastens the liquefaction of ice.	
14. The temperature obtained by a salt and ice mixture depends principally upon: a. Proportion of ice to salt. b. Size of ice lumps. c. Amount and density of the resulting brine. d. Rate at which heat is supplied from the outside.	
15. The freezing point of a liquid drops in direct proportion to the quantity and kind of solid dissolved in it.	
16. Salt is heavier than ice.	

Scientific Facts and Principles	Approved Practices
17. Rapid freezing or with little agitation tends to produce a coarse granular texture. Slow freezing and thorough agitation tend to produce a fine texture.	
18. Water tends to expand as it approaches the freezing point.	
19. In freezing a mixture too rapidly, the freezing point is reached before maximum swell is obtained.	
20. Prolonged beating or agitation causes mixture to break down with a loss of the incorporated air.	
21. The ripening process following the freezing binds and mellows flavors.	Allow ice cream to ripen after it is frozen.
22. Metals are excellent conductors of heat.	

Scientific Facts and Principles	Approved Practices
23. Wood is a poor conductor of heat.	

Suggested Readings

Frozen Products

Halliday, E. G., Noble, I. T. *Hows and Whys of Cooking*, pp. 179–192.
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Chapter X

FOOD PRESERVATION

Canned and preserved foods are the chief means for securing variety in the season when fresh products are not easily available.

Suggested Questions on Food Preservation

1. What is the difference between sterilization and pasteurization?
2. What causes food spoilage?
3. Why is the statement "two hours from the garden to the can" a good rule to follow?
4. What acid foods are commonly canned?
5. What non-acid foods are commonly canned?
6. Explain special differences in the method used for canning acid and non-acid foods.
7. Is it safe to add vinegar or lemon juice to change the acidity of non-acid foods and then treat them as acid foods?
8. Is it safe to use chemical preservatives such as sodium benzoate to preserve foods?
9. When using the hot-pack method for canning when do you begin to count time for processing?
10. What are the steps in canning peas?
11. How do you inspect jars and canned food before serving the food?
12. Is it necessary to use sugar when canning fruits?

General Information

Food spoilage may be caused by *microorganisms* such as bacteria, yeasts, and molds; by *autolysis* by self-contained enzymes; or by chemical and physical decomposition.

The main factors influencing the growth of microorganisms in foods are the chemical composition; the water content; the reaction, whether acid, neutral, or alkaline; the temperature at which food is held; and for some the presence of oxygen.

The time required for destroying microorganisms depends upon the kind of organism, whether the organism is in the active or spore stage, the acidity of the medium, and the density of the medium.

Food preservation refers to all processes used to check or destroy the activity of spoilage agents, thereby retarding or preventing food deterioration.

Fermentation refers to any decomposition of carbohydrates. In its limited sense it refers only to their decomposition with the evolution of gas.

Putrefaction is the term applied to the decomposition of organic substances, chiefly of highly complex nature like proteins, under the influence of bacteria.

Certain diseases are caused by spoiled foods.

Botulism is caused by eating products in which the poison or toxin has been developed by the organism *Clostridium botulinum*.

Trichinosis is a disease caused by eating meat containing trichina (*Trichinella spiralis*). Because of the possibility of this parasite's being present in pork the meat for canning should be carefully cooked so that every part reaches a temperature of 137°F.

Methods of Food Preservation

Methods of food preservation are based upon processes which kill organisms or inhibit their growth and activity. The common methods are briefly described below.

Canning refers to the process by which (1) sufficient heat is applied to destroy the microorganisms that cause food spoilage, and (2) a perfect seal is provided to prevent entrance of other microorganisms.

Drying reduces the water content of food products to such a degree that development of the ordinary microorganisms responsible for decay is checked. Foods impregnated with salt need less drying than those containing little salt, because salt has an antiseptic as well as a preservative effect.

Freezing is now used for preserving fruits, vegetables, and meats for different periods of time. Freezing is not thought to affect the food value. Freezing kills some microorganisms and inactivates others. Enzyme action may continue during freezing, but at a reduced rate. Frozen products should be used at once after thawing as they deteriorate rapidly.

Pasteurization (applied to milk especially) refers to the process of heating the food to 143.6°F. or 62°C. and maintaining that temperature for 30 minutes. By the flash method the food is heated to 185°F. or 85°C. By either method the food is cooled immediately. The temperature of pasteurization used for milk and fruit juices is not high enough to produce changes to any great degree in the flavor or food value.

Salting or brining refers to food preservation by a salt solution. The concentration of salt needed for the preservation of a product may vary from 6% to 25%.

Simple storage is effective in so-called temperate climates. Certain products may be stored successfully, the low temperatures retarding the activity of spoilage agents. Relatively high humidity prevents drying or shriveling.

Smoking is used to impart an agreeable flavor to meats and fish. Heat and smoke exert a drying effect on the surface through dehydration; smoking closes the pores, thus preventing entrance of bacteria. It is usually combined with salt curing.

Sterilization refers to the process whereby sufficient heat (212°F. or 100 C. or higher) is applied to the food substance or container for a sufficient length of time to kill all the microorganisms present.

Some Approved Practices in Food Preservation

1. Use a pressure cooker for canning non-acid foods.
2. Cool cans as quickly as possible after product has been canned.
3. Be sure that the entire contents of the can have been heated to a temperature high enough to destroy harmful bacteria and their spores.
4. Tomatoes do not have to be processed as long as beans in order to be sure that *Clostridium botulinum* is destroyed.

5. Non-acid canned products should be boiled 10 minutes before eating. (Count time when boiling is vigorous.)
6. Store canned foods in a cool, dark place.
7. Keep fresh fruit in a cool place.
8. Some bacteria are useful in the preparation of certain cheeses, sauerkraut, vinegar, and fermented pickles.
9. Can fruits and vegetables as soon as possible after picking.
10. Meat may be frozen to stop the growth of putrefactive bacteria.
11. Place eggs in water glass or lime water to preserve them.
12. Air bread boxes frequently in the sun.
13. Dehydration may be used for preserving some fruits and vegetables.
14. Do not pack spinach in the can too tightly.

Add other approved practices.

List each of the approved practices in food preservation in the blank space opposite the fact or principle which affords a scientific basis for the practice.

Scientific Facts and Principles	Approved Practices
Bacteria	
1. Bacteria thrive in moisture, in a neutral solution, and in nitrogenous substances.	
2. Bacteria are much more resistant to heat than yeasts and molds.	

Scientific Facts and Principles	Approved Practices
3. The thermal death point of non-spore-forming bacteria is usually from 149°F. (65°C.) to 158°F. (70°C.)	
4. Optimum temperature for growth of bacteria is between 68°F. (20° C.) and 104°F. (40°C.)	
5. Growing or vegetative forms of bacteria cannot survive for any length of time at 212°F. (100°C.)	
6. Bacterial spores survive temperatures of dry heat as great as 284° F. (140°C.)	Use a pressure cooker for canning non-acid foods.
7. Practically all bacterial spores are killed by heating to 212°F. (100°C.) for 6 hours.	
8. All bacteria cultures exposed to sunlight for 1 to 2 hours are killed.	

Scientific Facts and Principles	Approved Practices
9. Some of the most resistant forms of bacteria such as *Clostridium botulinum* are present in the soil.	
10. At least one variety of *Clostridium botulinum* produces spores which survive the temperatures commonly used in cooking.	
11. The acidity of the medium greatly influences the time necessary to kill *Clostridium botulinum.*	
12. *Clostridium botulinum* is anaerobic, or grows in absence of air.	
13. *Clostridium botulinum* toxin is readily destroyed by heating to 176°F. (80°C.) for 10 minutes if the temperature is reached throughout the mixture for this length of time.	
14. Some bacteria produce insoluble gases within the container.	

Scientific Facts and Principles	Approved Practices
15. Some bacteria produce acids giving the familiar "flat sour." This type of spoilage takes place between 109°F. (43°C.) and 149° F. (65°C.)	
16. Some forms of bacteria are useful in food preservation and manufacture.	
	Yeasts
17. Yeasts thrive best in an acid or sweet medium, in a moderately warm temperature.	
18. Yeasts are easily killed by a temperature of 140°F. (60°C.)	
19. Mold and yeast spores are easily killed by a temperature of 212°F. (100°C.)	
20. Conditions which kill molds also destroy yeasts.	

Scientific Facts and Principles	Approved Practices
	Molds
21. Molds thrive best in: a. A moist environment. b. The absence of bright light. c. The presence of oxygen. d. A moderate amount of heat. e. An acid or sweet medium.	
22. Molds are easily killed by heating for a few minutes at boiling temperature 212°F. (100°C.).	
23. Certain molds play an important role in the manufacture of some foods.	
	Enzymes
24. Enzymes bring about the normal ripening of fruits, vegetables, and meats.	
25. Enzyme activity is affected by: a. Concentration of substrate. b. Concentration of enzyme. c. Temperature. d. Time. e. H-ion concentration.	
26. Enzymes are most effective at temperatures ranging from 79°F. (26°C.) to 111°F. (44°C.).	

Scientific Facts and Principles	Approved Practices
27. Enzymes are destroyed by heating to 212° F. (100° C.) for a short time.	
28. Some enzymes bring about decomposition of food unless the action is checked.	

Methods of Food Preservation

The individual constitution of each product determines its form of decomposition and accordingly determines the best method of food preservation.

Scientific Facts and Principles	Approved Practices
	Canning
29. Spoilage in canned products may be due to: a. Enzymes. b. Chemical processes. c. Microorganisms.	
30. The temperature and time necessary for sterilization depend upon the composition of the food.	
31. The temperature and time of sterilization depend upon the pack of the container (whether tight or loose).	Care must be taken not to pack spinach too tightly in the can.

Scientific Facts and Principles	Approved Practices
32. Sterilization must be accompanied or followed by sealing the product in air-tight containers.	
33. Steam confined in a closed space will reach temperatures above 212°F. (100°C.).	
34. The organisms that cause food spoilage grow most rapidly and are most active at high temperatures.	
35. At temperatures near the freezing point, the growth of microorganisms is almost completely stopped.	
36. Moisture is necessary for the growth of microscopic organisms. Ventilation aids in the removing of surface moisture.	*Drying*
37. Three per cent acetic acid is sufficient to preserve most food products.	*Acids, Condiments, Spices*

Scientific Facts and Principles	Approved Practices
38. A few essential oils found in spices have a rather high antiseptic value. Condiments and spices used in small quantities for flavor exert no preservative action.	

Suggested Readings

Food Preservation

Buchanan, E. D., Buchanan, R. E. *Bacteriology for Students in General Household Science*, pp. 532.
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Macleod, A. L., Nason, E. H. *Chemistry and Cookery*, Second Edition, pp. 419–442.
Stanley, L., Stienbarger, M. C. *Home Canning of Fruits, Vegetables, and Meat.* Farmers' Bulletin 1762, U. S. D. A., 1936.
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Chapter XI

JELLY MAKING

According to Goldthwaite,[1] an ideal fruit jelly is a delicious, appetizing substance which is clear and beautifully colored. It is not syrupy, gummy, or tough. Instead, it will quiver but not flow when removed from the mold; it is tender enough to be cut easily with a spoon and yet so firm that the angles produced when it is cut retain their shape. It is not brittle, but it will break with a distinct cleavage which leaves sparkling faces. To this description one may add that it has the characteristic flavor of the fruit from which it is made and is usually sub-acid to tart in taste.

Questions on the Preparation of Jelly

1. What are three essentials in jelly making?
2. How may the juice be tested to determine its fitness for jelly?
3. List fruits in your section of the country which may satisfactorily be used in jelly making.
4. How should juice be extracted from hard fruits? Soft fruits?
5. When should sugar be added in the preparation of jelly?
6. How may fruit pulp be used after the juice has been strained from it?
7. How much jelly should be made at one time? Why?
8. How should glasses be prepared for jelly?
9. How is jelly tested for doneness?
10. Why does jelly sometimes not set, even though it gives the jelly test?
11. What are some of the causes of common jelly failures?
12. Does jelly made with beet sugar keep as well as that made with cane sugar?
13. If a fruit is low in acid how can the juice be corrected to make a good jelly?
14. If a fruit is low in pectin how can the juice be corrected to make a good jelly?

Requirements of Jelly Fruit

Jelly is the product which results from cooking a fruit juice with sugar to such a point of concentration that it congeals or sets upon cooling. An ideal jelly fruit is rich in acid and pectin and has a good flavor. Since few fruits attain this ideal naturally, corrections are often necessary to produce a standard jelly. The fruits which most nearly meet the requirements of an ideal jelly are:

Apples, crab.
Apples, sour.
Blueberries.
Cranberries.
Currants.
Grapes, wild, Concord or beta.
Gooseberries.
Plums, sour.
Quinces, sour.

[1] Goldthwaite, N. E. Col. Expt. Sta. Bull. 298:7. 1929.

To prepare the standard jelly described above, there must be a correct balance between the pectin, acid, and sugar.

Pectin

Pectin, the jellying substance, is found in most fruits and vegetables in varying amounts; variations may be due to variety, degree of ripeness, or season. There are two types of pectin in fruits, the water-soluble and the water-insoluble. *Water-soluble pectin* is found in the uncooked fruit juice, and to some extent in the fruit pulp, and its jellying power is usually somewhat less than that of pectins derived by hydrolysis from the water-insoluble form. *Protopectin* is the *water-insoluble* precursor of pectin; it occurs in the cell walls and middle lamella of plant tissues and may be hydrolyzed with boiling water, dilute acids, or the enzyme protopectinase to yield pectin. If the action continues, pectic acid is formed. Protopectin and pectic acid do not have jellying power.

The amount of pectin present in an extracted fruit juice is affected by the length of the extraction period, the *p*H of the extraction medium, the variety of fruit used, and the method of cutting the fruit.

Acid

The quantity of acid present affects the texture, flavor, and appearance of the jelly. Lemon juice may be used to increase the acidity of the fruit juice; malic or tartaric acid may also be used.

Sugar

Cane and beet sugar give equally satisfactory results in the preparation of jelly. The quantity of sugar affects the texture, flavor, appearance, and yield of jelly. Honey, glucose, or cane syrup may be used in jelly to replace part of the sugar.

Color of Jelly

The color of jelly varies with the kind and quantity of sugar, the H-ion concentration, the length of boiling period, and the method of cutting the fruit.

Other factors being constant, the smaller the proportion of sugar the darker the color of the jelly. Honey and glucose give a darker color than sucrose; acid accentuates any color already present. The shorter the boiling period the brighter the color. Slicing apples gives a better colored jelly than grinding them.

Technical Vocabulary for Jellymaking

H-ion concentration
pectin
pectic acid
protopectin
protopectinase
syneresis
titratable acidity
viscosity

Some Approved Practices in the Preparation of Jelly

1. Boil fruit for a short time to extract pectin.
2. Do not add too much water when extracting pectin.

3. Add acid before extraction to fruit which is known to be deficient in acid, since it not only corrects acidity, but also tends to extract more pectin.
4. One tablespoon of lemon juice may be added to each cup of fruit juice after extraction.
5. Fruit juice which is not sufficiently acid may be combined with an acid juice such as currant or apple.
6. Juice extracted from ripe fruit may need to have acid added.
7. If a juice is lacking in pectin add commercial pectin until the juice gives a desirable pectin test, or combine with a juice which is rich in pectin, e.g., raspberry juice with Greening apple juice.
8. The quantity of pectin present in a fruit juice may be roughly estimated by treating the solution with alcohol. Mix 1 tablespoon of cold fruit juice with 2 tablespoons of alcohol (absolute, denatured, or wood alcohol).
   a. In excellent jellying juice, the pectin precipitates in a solid mass almost immediately, with little or no liquid left.
   b. In good jellying juice, the pectin precipitates quickly in two or three large masses, but the volume is good.
   c. In fair to poor jellying juice, the pectin may collect in a flocculent precipitate, or there may be no precipitate.
9. If juice is poor in pectin, add pectin rather than boiling until solution is more concentrated.
10. If the alcohol test for pectin is used, the estimated amounts of sugar are:
    Excellent pectin: use 1 cup sugar to 1 cup juice.
    Good pectin: use ¾ cup sugar to 1 cup juice.
    Fair pectin: use ½ cup sugar to 1 cup juice.
    Poor pectin: will not make jelly without pectin being added, after which the juice should be tested again.
11. Do not substitute more than half the sugar by glucose or honey.
12. Use a Jelmeter (Jelmeter Co., Bridgeton, N. J.) for determining viscosity, and follow directions which come with the Jelmeter for cooking by weight.
13. Use a Jelmeter to determine proportions of sugar which should be used.
14. Use a kettle large enough to allow the juice to boil rapidly. Juice should not come up more than one-fourth the height of the kettle before it starts to boil.
15. The boiling period for apples and plums and other hard fruits averages 15 to 20 minutes; for soft fruits, such as berries, 8 minutes.
16. Cook juice in small quantities, not more than 1 to 5 cups at a time.
17. Set jelly kettle aside when making "sheeting off" test to avoid possible overcooking.
18. Sterilize clean jelly glasses by boiling for 10 minutes in a pan of water.
19. Any scum which has been formed should be removed after kettle has been removed from heat, and before it is poured into the jelly glasses.
20. Either place a very thin layer of hot paraffin over the jelly immediately after pouring into the glasses or cover the glasses with a thin piece of cheesecloth until the jelly has set and then paraffin. Add more paraffin after jelly has set and is cold.

Add other approved practices.

List each of the approved practices in the preparation of jelly in the blank space opposite the fact or principle which affords a scientific basis for the practice.

Scientific Facts and Principles	Approved Practices
1. As fruits ripen, the protopectin changes to soluble pectin and this in turn to pectic acid.	
2. Boiling fruit juice changes protopectin into soluble pectin. Prolonged boiling produces pectic acid.	
3. Underripe or green fruits contain a small proportion of pectin but a larger percentage of protopectin. Overripe fruits contain a small percentage of pectin but a larger percentage of pectic acid.	Use fruit that is just ripe or slightly underripe in preference to a green or overripe fruit for jelly.
4. The maximum percentage of pectin is present in slightly underripe fruit.	
5. The amount of pectin present in fruit is affected by its maturity, the variety, and the season of the year.	

Scientific Facts and Principles	Approved Practices
6. Pectin is extracted more rapidly in an acid medium. Fruit yields the optimum amount of pectin when the *p*H is about 3.0.	
7. Fruit juices may be corrected for acid deficiency after extraction.	
8. The *p*H of fruit juice seems to be of more importance than the titratable acidity.	The tart taste in a fruit juice may not always be a safe estimate of the *p*H of a fruit juice.
9. Pectin as well as any gums or starch present in a fruit juice is precipitated by alcohol.	The quantity of pectin present in a fruit juice may be roughly estimated by treating the solution with alcohol. Mix 1 tb. of cold fruit juice with 2 tb. of alcohol (absolute or denatured). a. In excellent jellying juice, the pectin precipitates in a solid mass almost immediately with little or no liquid left. b. In good jellying juice, the pectin precipitates quickly in two or three large masses, but the volume is good. c. In fair to poor jellying juice, the pectin may collect in a flocculent precipitate or no precipitate.
10. Fruit juices which contain very low concentration of pectin (those giving poor alcohol tests) cannot be boiled down to concentrate the pectin without hydrolysis of the pectin to pectic acid.	

Scientific Facts and Principles	Approved Practices
11. Fruits of good flavor which are poor in pectin can be made into a standard jelly by correcting the pectin content.	
12. The quantity of sugar which a juice will support determines the yield of jelly. The quantity of sugar varies with: a. Pectin concentration. b. H-ion concentration. The higher the pectin content of the juice, and the higher the H-ion concentration, to a certain point, the greater the amount of sugar which the juice will support.	If the alcohol test for pectin is used the estimated amounts of sugar are: Excellent pectin: use 1 c. sugar to 1 c. juice. Good pectin: use ¾ c. sugar to 1 c. juice. Fair pectin: use ½ c. sugar to 1 c. juice. Poor pectin: will not make jelly without added pectin after which the juice should be retested.
13. Pectin disperses in water to form a colloidal sol, one property of such a sol being viscosity. The jellying qualities of a fruit juice vary directly with its viscosity.	
14. The amount of sugar to use to produce a jelly may be determined from viscosity tests of the fruit juice.	Test the juice with a Jelmeter[1] to determine the relative viscosity, and use the proportions of sugar specified by the directions which accompany it.
15. Hydrolysis of pectin to pectic acid is retarded when sugar is present.	Add sugar before beginning to cook jelly.

[1] Jelmeter Co., Bridgeton, N. J.

Scientific Facts and Principles	Approved Practices
16. Fructose and glucose may be used in place of sucrose for jelly; such jellies are slightly darker than sucrose jelly.	
17. Jelly may be cooked to a predetermined weight if the concentration of pectin to sugar is definitely known.	Use a Jelmeter[1] for determining viscosity, and follow directions for cooking by weight which come with Jelmeter.
18. The "jell point" may be determined, with a fair degree of accuracy, by means of "sheeting-off" test.	
19. The extent of the boiling period for obtaining pectin varies with: a. Character of fruit; whether hard—apples, plums, etc.; or soft—berries. b. Acidity of medium.	
20. Rapid cooking results in a jelly of superior color and flavor.	
21. Syneresis occurs when the H-ion concentration of the juice is much greater than 3.1.	

Scientific Facts and Principles	Approved Practices
22. Ripe fruit has a better flavor than green fruit but a lower acidity.	
23. Second extractions of fruit juice are less acid and poorer in pectin and flavor than first extractions.	
24. Scum formed on the surface of the jelly during cooking may be due to impurities in the sugar or to sediment in the fruit juice.	
25. Jelly which is put into unsterile glasses may mold or ferment.	
26. The air currents in a room carry molds and bacteria which may settle on the top of jelly which is not sealed.	

Suggested Readings

Jelly Making

Chenoweth, W. W. *Food Preservation*, 344 pp.
Goldthwaite, N. E. *Principles of Making Fruit Jellies.* Col. Agr. Expt. Sta. Bull. 298.
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APPENDIX

GLOSSARY OF GENERAL TERMS USED IN FOOD PREPARATION STUDIES

The following terms are often used in discussing the science of food preparation.

1. Absorption is the taking up of a liquid by solid materials which may be removed again by physical methods such as squeezing, pressing, etc.
2. Acids are substances which ionize in solution to give H-ions.
3. Adsorption is the increase in concentration at a solid surface or at a liquid interface which usually reduces the interfacial tension.
4. Bases or alkalis are substances which ionize in solution to give OH-ions.
5. A chemical reaction is the action that takes place within one or between two or more substances during which one or more new substances are formed.
6. Compounds can be broken down into simpler substances known as elements.
7. Diffusion is the molecular mixing of two fluids (gas, liquids, or solutions) until a uniform mixture is formed.
8. Fluids yield to any force that tends to change their form.
9. A gel is a lyophilic colloid in which the solvent is supported by the colloidal material. Gels may be considered to have structure, a definite arrangement of colloidal particles.
10. Hydration is the process of the union of water with a substance. The compounds are known as hydrates. (Little is known about the actual union, but hydrated materials may frequently be quite readily dissociated into the original substance and water.)
11. Hydrolysis is the process of decomposition in which the materials take up the elements of water (H_2O) chemically.
12. Inversion is the chemical process (hydrolysis) by which one molecule of sucrose is made to unite with water to form one molecule each of glucose and fructose.
13. Ionization is the dissociation of a molecule of a compound into positive and negative ions. Ions may originate from single atoms (Cl) or groups of atoms that are tightly held in place and act as a kind of a unit (SO_4).
14. Isoelectric point is expressed as *p*H and is the point at which there is no movement of colloidal particles carrying charges because these particles are electrically neutral.
15. Lyophilic substances are those which are solvent loving. Hydrophylic substances are those which take up water readily.
16. Lyophobic substances are those which are solvent hating. Hydrophobic substances are those which repel water.
17. Melting point is the temperature at which a solid changes to a liquid.
18. Mixtures are aggregations of substances which can be separated by physical methods.
19. Osmosis is the physical movement of a solvent through a semipermeable membrane from a less to a more concentrated solution.
20. Oxidation and reduction involve changes in electrons. When an atom loses an electron it is oxidized. When an atom gains an electron it is reduced. Oxidation and reduction always occur simultaneously.

21. Physical reactions are changes in which the identity of the substance or substances involved is not changed.
22. *p*H value of a solution is a scale for expressing the hydrogen-ion concentration in that solution.
23. Plasticity is the property of gels which permits them to yield under pressure but to return to their original shape. When the pressure gradient destroys the gel structure the gel acts like a liquid and flows viscously.
24. Reduction. *See* Oxidation.
25. Sols are colloidal suspensions which behave like true solutions.
26. Solutions:
    a. True solutions are those in which the solute is dispersed in the solvent in molecular size.
    b. Unsaturated solution is a solution that does not contain so much of that solute as the solvent can hold in solution at that temperature.
    c. Saturated solution is a solution that contains as much of the solute in solution as possible at that temperature.
    d. Supersaturated solution is one that contains more of the solute than can ordinarily be held at that temperature. This is usually produced by gradually cooling a solution which has been saturated at some higher temperature.
27. Surface tension is the tendency of a liquid to assume the smallest possible surface.
28. Syneresis is the bleeding or seeping of a gel. The fluid is not water but a sol that has the same composition as the gel.
29. Viscosity is the internal resistance of a liquid to flow in the direction of a lower pressure. *See* Plasticity.

JUDGING FOOD PRODUCTS

The preparation of appetizing foods necessitates a knowledge of what constitutes a satisfactory product, and it is desirable to have the ability to ascertain the reason why certain products do not measure up to the standard.

As we see food which has been prepared we automatically judge it; certain impressions are made regarding the general appearance, and if the product is tasted, other qualities will be judged in the same superficial manner. However, judging with a score card will necessitate a more thorough and critical examination with a definite record of the judgment. No discussion should be allowed while judging is in progress, as a student's decision may be biased. A general discussion should follow the independent scoring which will emphasize the standard comparison with the good and the poor points of the product. This is the most valuable class procedure in aiding the instructor to set up a desirable standard for each product in the mind of the student.

In experimental food classes, when the products to be judged have variants the judge should not know the exact variant in each product. This will enable her to give an unbiased opinion. For example, if muffins are prepared with the three types of baking powder and there may be a prejudice against one of the types, a fair decision is not likely to be given if the type used in each sample is known. In asking persons to judge these muffins a proper statement is: "The variant in these muffins is type of baking powder. Kindly score and record your judgment."

If much judging is done, a little bread, apple, or a drink of water between sampling helps free the mouth from definite flavors.

Several types of score cards follow; modifications of these may be prepared. The type should be chosen according to the product, time for judging, and the use which is to be made of results. Variations in each type may also be made, depending upon the data to be secured.

Definitions of Terms Used in Score Cards

Appearance: Aspect or contour.
Color: A shade, tint, or hue.
Consistency: Degree of firmness; density; viscosity; resistance to movement.
Flavor: Quality which affects the relish, zest, or savor; closely associated with aroma.
Lightness: Well leavened; not dense; having low specific gravity.
Moisture content: Degree of moisture.
Size: Height; diameter or circumference; bulk; proportionate dimensions.
Taste: The sense by which acid, bitter, salt, and sweet are ascertained by contact with the taste buds of the tongue.
Tenderness: Ease with which anything can be cut, broken, or masticated.
Texture: Structural quality; disposition of different ingredients or parts in relation to each other

TYPE I[1]

This score card has been found to be efficient in building up a consciousness for standard products and training in independent evaluation in beginning food classes and can be very quickly used.

SCORE CARD FOR BAKING POWDER BISCUITS

	0	1	2	Score
Appearance	1. Very rough top		Fairly smooth and level top	1.
Color: Exterior	2. Pale or dark brown		Golden brown	2.
Interior	3. Gray, yellow, or spotted		Creamy white	3.
Moisture content	4. Dry or insufficiently baked		Slightly moist	4.
Texture	5. Bready		Flaky	5.
	6. Coarse grain; crumbly		Medium fine grain	6.
Lightness	7. Heavy		Light	7.
Tenderness	8. Crust tough and hard		Crust crisp and tender	8.
Taste and flavor	9. Flat or tastes of fat or leavening agent		Pleasing flavor	9.
				Score

[1] Developed by Clara M. Brown.

TYPE II

This score card includes a definite standard which helps the beginner to know what to look for when judging. After several products are scored the total scores may be compared.

Score Card for Muffins

Date..... Judge..... Possible Score, 65

Standard	Possible Score	Score for Sample			
		I	II	III	IV
A. Shape					
Slightly rounded top	5				
Symmetrical	5				
Pebbled top	5				
B. Color					
Even	5				
Golden brown	5				
C. Texture					
1. Crust					
Tender	5				
Thin	5				
2. Crumb					
Moist	5				
Tender	5				
No tunnels	5				
Medium fine grain	5				
D. Flavor					
Pleasing	5				
Well blended	5				
Total Score	65				

Kindly judge without discussion, using the following numerical rating:
1 for very poor
2 for poor
3 for fair
4 for good
5 for standard

Comments by judge:

TYPE III

This score card gives definite qualities for which to look. It also is a quick way of finding what qualities the product has and of comparing the qualities of a number of products by means of a definite score.

SCORE CARD FOR BAKED POTATOES

Date..... Judge.....

Quality	Description and Numerical Rating				Score
Flavor.....	1 Strong	2 Slightly strong	3 Flat	4 Mild	
Interior color.....	1 Dark	2 Yellow	3 Cream	4 White	
Texture.....	1 Very soggy	2 Soggy	3 Slightly mealy	4 Mealy	
Total.....					

Check the word which gives your opinion of each quality and record the numerical rating in the score column.

Kindly judge without discussion.

TYPE IV

This score card may be used for simple judging when the different qualities are to be judged; it gives data for comparing separate qualities in the product.

SCORE CARD FOR CRISP MOLASSES COOKIES

Date.....

Judge..... Possible Score, 16

Description and Numerical Rating

Quality	4	3	2	1	0	Judge's Score
Color.....	Excellent	Good	Fair	Poor	Objectionable	
Texture.....	Excellent	Good	Fair	Poor	Objectionable	
Aroma.....	Excellent	Good	Fair	Poor	Objectionable	
Flavor.....	Excellent	Good	Fair	Poor	Objectionable	

Total Score

Check the word which gives your opinion of each quality.
Kindly judge without discussion.

TYPE V

This score card may be used for very quick judging when time is limited.

SCORE CARD FOR GRIDDLE CAKES

Date..... Judge.....

Check your estimate of product	Suggestions for improving product:
Superior.....	
Very good.....	
Good.....	
Poor.....	
Very poor.....	

TYPE VI. SHEET A

Apple Sauce Rating Sheet[1]

This type of rating sheet is especially useful in experimental work and seems to give more uniform scoring by judges. The standard is given in the first line under qualities for each factor, and in the subsequent lines suggestions are given as to how the product may differ from the standard.

Factor	Qualities	Rating
Consistency	Slightly rounded mass	18–20
	Flows enough to level, slight separation	14–17
	Thin and watery, separation of free liquor	0–13
Color	Typical, uniform, bright color throughout	18–20
	Slightly lacking in uniformity	14–17
	Poor color	0–13
Finish	Fine-grained and smooth, pulp evenly divided, granular but not lumpy	18–20
	Somewhat pasty, lacks granular characteristics	14–17
	Decidedly pasty or lumpy, or coarse	0–13
Absence of defects	Practically free from defects, seeds, flecks, bruises, grit, etc.	18–20
	Reasonably free from defects	14–17
	Defects prominent	0–13
Flavor	Characteristic apple flavor prominent and distinct	18–20
	Apple flavor desirable but not prominent	14–17
	Flavor poor, "off" flavor of overripe or held fruit.	0–13

[1] Adapted from grading sheet by Bureau of Economics, U. S. D. A.

TYPE VI. SHEET B

Apple Sauce Rating Sheet

Sheet for the judges' scores when using Apple Sauce Rating Sheet A.

Judge..... Date.....

		Samples			
		1	2	3	4
	Standard				
I. Consistency	20				
II. Color	20				
III. Finish	20				
IV. Absence of defects	20				
V. Flavor	20				
Total Score	100				

TYPE VII

This type of record sheet is especially adapted for experimental food preparation; it gives a method for comparing the products according to quality without definite ratings. In experimental work a record sheet of this type helps in comparing the different qualities of a product after a large number have been prepared, and also in making a decision as to what the desirable qualities are. These record sheets should be prepared according to the data desired, and thus more valuable conclusions will result.

RECORD SHEET FOR BUTTERLESS CAKE (with whole egg)

Date..... Sample No.....

Judge..... Kind of cake.....

		Description					
Exterior	Shape	Very rounded top	Moderately rounded	Slightly rounded	Flat	Slightly concave	Very concave
	Color	Very even	Moderately even	Slightly even	Slightly uneven	Moderately uneven	Very uneven
		Medium brown	Light brown	Yellow	Cream	White	Grey
	Crust	Very thin	Moderately thin	Slightly thin	Slightly thick	Moderately thick	Very thick
		Very dry	Moderately dry	Slightly dry	Slightly moist	Moderately moist	Very moist
Interior	Crumb	Very moist	Moderately moist	Slightly moist	Slightly dry	Moderately dry	Very dry
		Very tender	Moderately tender	Slightly tender	Slightly tough	Moderately tough	Very tough
	Grain	Very even	Moderately even	Slightly even	Slightly uneven	Moderately uneven	Very uneven
		Very fine	Moderately fine	Slightly fine	Slightly coarse	Moderately coarse	Very coarse
	Flavor	Very pronounced	Moderately pronounced	Slightly pronounced	Perceptible	Trace	Imperceptible
		Very desirable	Desirable	Moderately desirable	Slightly desirable	Neutral or imperceptible	Undesirable
	Color	Yellow	Cream	Cream white	White	Grey white	Grey

Check the word which gives your opinion of each quality.
Kindly judge without discussion.

APPROXIMATE BASIC PROPORTIONS AND SUBSTITUTIONS

The section, Basic Proportions and Substitutions, has been planned primarily to assist students in constructing and evaluating recipes and in making correct substitutions. The knowledge of basic proportions will give greater freedom, or almost complete freedom, from recipes of the ordinary products prepared. This has distinct advantages and is particularly valuable for beginners. Fundamental food training should strive to give to students the ability to build recipes for every-day foods and to know when these recipes are desirable and satisfactory. For certain types of dishes, definite recipes are unnecessary—for example, cream soups, escalloped dishes, etc.—if basic proportions are followed.

I. Batters and Doughs

1. *Flour Substitution*

For 1 c. bread flour substitute 1⅛ c. cake or pastry flour.
For 1 c. cake or pastry flour substitute ⅞ c. bread flour.
For 1 c. bread flour substitute: ⅓c. corn meal and
⅔ c. bread flour.
For 1 c. bread flour substitute: ½ c. Graham or whole wheat and
½ c. bread flour.

More of the coarse flours may be substituted for the white bread flour, but the resulting products will be somewhat different from the standard generally accepted for the bread flour products.

2. *Leavening*

a. The steam from 1 c. liquid leavens 1 c. flour.
b. For each additional cup of flour additional leavening agent must be used.
c. One-half teaspoon of baking soda neutralizes 1 c. sour milk (well clabbered).
d. One-half teaspoon of soda neutralizes 1 c. of molasses.
e. One-fifth teaspoon of soda neutralizes 1 sq. chocolate.
f. The leavening produced by neutralizing 1 t. soda with acid is equivalent to the leavening of 4 t. baking powder.

3. *Shortening*

For 1 c. flour in biscuit and shortcake use 1 tb. to 6 tb. shortening.
For 1 c. flour in muffins use 1 tb. to 4 tb. shortening.
For 1 c. flour in plain pastry use ¼ to ⅓ c. shortening.

Shortening Substitution

Unless the kind of fat is specified, all recipes are based on 100% fats.

For 1 c. of 100% fat substitute 1⅛ c. (or 2 tb. more) of 80% fat.
For 1 c. of 85% fat substitute ⅞ c. or (2 tb. less) of 100% fat.

100% fats		*approximately 80% to 85% fats*
Bacon and chicken fat	approximately	Butter
Hydrogenated oils		Margarine
Lard		
Lard substitutes		
Oil		

Cream as Shortening

Although some equivalents have been set up, it is more satisfactory to use recipes that have been definitely worked out for the use of sweet and sour cream.

4. *Salt*

For each 1 c. flour use from ¼ t. salt to ½ t. salt when unsalted shortening is used in batter and dough products.

II. Beverages

Beverage	*Liquid*	*Flavoring Material*
1. Chocolate	1 c.	¼ sq. to ½ sq.
2. Cocoa	1 c.	2 t. to 3 t.
½ sq. chocolate is equivalent to 3 t. cocoa		
3. Coffee	1 c. water	2 tb. medium grind
4. Tea	1 c. water	¼ t. to 1 t.

III. Cereals and Macaroni

1. *Breakfast Cereals*

	Dry Cereal	*Liquid*
Partially cooked (rolled or flakes)	1 c.	2 c. to 3 c.
Uncooked—cracked	1 c.	4 c. to 5 c.
" —granular	1 c.	5 c. to 6 c.
" —whole	1 c.	4 c. to 5 c.

If all milk is used, more liquid will be required.
Salt: a scant ¼ t. to ½ t. per cup of liquid.
Expansion of cereals when steamed is approximately equivalent to the quantity of liquid used in cooking.

2. *Macaroni and Other Italian Pastes:*

From 8 c. to 12 c. *boiling* water to each 1 c. of material.
Salt: ¼ t. salt to each 1 c. of water used.
Expansion of product is approximately 2 times original bulk.

IV. Freezing Mixtures

For "stirred" frozen desserts use 1 part salt to 8 parts ice by volume.
For "still" freezes use 1 part salt to 4 to 8 parts ice by volume.
For packing all types use 1 part salt to 4 to 8 parts ice by volume.

V. Salad Dressings

For French dressing use ¼ c. to ½ c. acid to 1 c. oil.
For mayonnaise use 1 tb. to 4 tb. acid to 1 c. oil.
For mayonnaise 1 egg yolk, or 1 egg white will emulsify approximately 1 c. oil.
For seasoning use ½ t. salt to 1 c. oil.

VI. Sugar

Desserts:

For 1 c. liquid in most desserts use 2 tb. sugar.
For 1 c. liquid in ice creams use 2 to 4 tb. sugar.
For frostings use ⅞ c. to 1⅛ c. for each egg white.
For soft meringues use 1 tb. to 2 tb. for each egg white.
For hard meringues use 4 tb. to 6 tb. for each egg white.

VII. Thickening Agents

For 1 c. liquid in creamy pudding use 1 tb. cornstarch.
For 1 c. liquid in molded pudding use 1¼ tb. to 1½ tb. cornstarch.
Flour has approximately ½ the thickening power of cornstarch.
Browned flour has approximately ½ the thickening power of flour, depending upon the degree of dextrinization.
For 1 c. liquid in custards, use 1 medium-sized whole egg or 2 yolks.
2 t. cornstarch has approximately the same thickening power as 1 egg.
For 1 c. liquid in gelatin mixtures use 1½ t. gelatin.
For 1 c. liquid in tapioca puddings use 2½ tb. minute (6 tb. pearl) tapioca.

VIII. Vegetables

For boiling vegetables use 1 t. to 1½ t. salt per quart of boiling water.
For buttering vegetables allow 1 t. butter to each ½ c. of vegetable.

UNIT MEASURES OF FOOD

Some Data for Estimating Quantities[1]

Name	Purchasing Unit	Measure in Unit
Almonds (shelled)	1 lb.	2½ c. (1 lb. unshelled make ½ lb. meats).
Apples (fresh)	1 lb.	2 to 3 apples—1 bu. = 44 to 50 lbs.
Apricots (fresh)	1 lb.	About 6 apricots.
Apricots (dried)	1 lb.	About 3 c. Double in bulk when cooked.
Bacon (medium strip)	1 lb.	30 full thin slices.
Bacon (wide strip)	1 lb.	About 15 thin slices.
Baking powder		1 oz. = 3 tb.
Bananas	1 lb.	About 3 bananas.
Beans (dried)	1 lb.	About 2 c. (increase 2 or 3 times in bulk in cooking).
Beans (Lima, dried)	1 lb.	About 2⅓ c. (increase 2 to 3 times in bulk in cooking).
Beans (fresh)		1 bu. = 60 lbs.
Beets	1 lb.	2 to 3 beets—1 bu. = 60 lbs.
Bread	1½ lb. loaf	About 15 slices ½ in. thick.
	2 lb. loaf	24 slices ½ in. thick.
Bread (sandwich)	1 loaf	30 to 40 slices ¼ in. thick.
Butter	1 lb.	About 2 c.—32 servings of 1 tb. each. 2 tb. = 1 oz.
Carrots	1 lb.	3 to 5 carrots—1 bu. = 50 lbs.
Cauliflower	1 head	May weigh 1 to 3 lbs. or more.
Cheese (cottage)	1 lb.	2 c.
Cheese (American)	1 lb.	4 c. grated.
Cherries (candied)	1 lb.	About 120 cherries.
Chocolate	1 lb.	16 sq.
Cocoa	1 lb.	4 to 4½ c.
Cocoanut (shredded)	1 lb.	6 c.
Coffee (ground)	1 lb.	4½-5 c. of medium grind.
Corn meal	1 lb.	3 c.

[1] Many of these measures are the result of experimental work and where possible have been checked with various sources of data.

Name	Purchasing Unit	Measure in Unit
Cornstarch	1 lb.	3 c.
Crackers (Graham)	1 lb.	About 40 crackers.
Crackers (oyster)	1 lb.	450 to 500 crackers.
Crackers (saltine)	1 lb.	About 125 crackers.
Crackers (saltine)	1 lb.	1 c. crumbs from 16 finely rolled.
Crackers (soda)	1 lb.	70 to 90 crackers.
Cranberries	1 lb.	About 4 c.—1 bu. = 32 to 40 lbs.
Currants (dried)	1 lb.	About 2⅔ c.
Dates	10 oz. pkg.	50 to 60 dates.
Egg whites		8 to 11 whites to 1 c.
Egg yolks		About 12 yolks to 1 c.
Eggs (whole)		4 to 6 eggs to 1 c.
Figs (pressed)	1 lb.	About 4 c.
Figs (small)	1 lb.	10 to 11 figs.
Figs (medium)	1 lb.	8 to 9 figs.
Figs (large)	1 lb.	6 figs.
Flour (white)	1 lb.	About 4 c.
Flour (Graham)	1 lb.	4 to 4½ c.
Lard	1 lb.	2 c.
Lemons	1 lb.	3 to 5 lemons. 1 lemon gives about 4 tb. of juice.
Marshmallows	1 lb.	80 to 90 marshmallows.
Mints	1 lb.	Averages 50 after-dinner mints.
Oats (rolled)	1 lb.	About 5½ c.
Oatmeal	1 lb.	About 3 c.
Oils	1 lb.	2 c.
Olives	1 qt.	60 to 70 olives.
Onions	1 lb.	4 to 12 onions—1 bu. = 50 to 57 lbs.
Oysters	1 qt.	40 to 60 oysters.
Parsnips	1 lb.	2 to 5 parsnips—1 bu. = 42 to 50 lbs.
Peaches (fresh)	1 lb.	3 to 5 peaches—1 bu. = 40 to 54 lbs.

Name	Purchasing Unit	Measure in Unit
Peaches (dried)	1 lb.	About double in bulk when cooked—1 bu. = 33 lbs.
Peanuts (shelled)	1 lb.	About 2⅔ c.
Peanut butter	1 lb.	About 1¾ c.
Pears	1 lb.	3 to 4 pears (1 bu. = 45 to 58 lbs).
Peas (in pod)	1 lb.	2 to 3 servings (1 bu. = 60 lbs.).
Pecans (shelled)	1 lb.	3 to 4 c.
Potatoes (Irish)	1 lb.	2 to 4 potatoes (1 bu. = 60 lbs.).
Potatoes (sweet)	1 lb.	2 to 3 potatoes (1 bu. = 50 to 65 lbs.).
Prunes	1 lb.	20 to 80 prunes, average 40 to 60.
Raisins (seedless)	1 lb.	About 2⅔ c.
Rice	1 lb.	About 2 c.
Spinach	1 lb.	About 2½ qt. (uncooked). 1 lb. makes 3 to 4 servings.
Sugar (granulated)	1 lb.	About 2 c.
Sugar (brown)	1 lb.	2½ to 2¾ c., depending on moisture.
Sugar (confectioner's)	1 lb.	3½ c.
Sugar (powdered)	1 lb.	2½ to 2¾ c.
Sugar (loaf) Domino	1 lb.	90 pieces.
Sugar (C&H ½ in. cubes)	1 lb.	120 pieces.
Tapioca	1 lb.	2½ c.
Tea	1 lb.	6½ c.
Tomatoes	1 lb.	2 to 5 tomatoes (1 bu. = 45 to 60 lbs.).
Vanilla (liquid)	1 oz.	2 tb.
Walnuts (shelled)	1 lb.	About 4 to 5 c.

WEIGHTS OF SOME FOOD MATERIALS USED IN FOOD PREPARATIONS[1]

Food	Form or Kind	One Cup	Miscellaneous Measures
		Grams	
Bread crumbs	Dry—sifted	56.0	
	grated	88.0	
	Fresh	46.0	
Cereals			
Hominy	Coarse	182.0	
	Grits	154.0	
Oats	Rolled (quick)	80.0	
Rice	Polished, whole	208.0	
Wheat	Whole	198.0	
Cheese	Cheddar, soft, grated	200.0	
Chocolate	Grated	132.0	
Cocoa	Stirred	112.0	
Coffee	Drip-grind	84.0	
	Percolator	82.0	
	Pulverized	88.0	
Eggs	Whole—without shell	5 med.—243.0	1 egg 48.0
	White	8 med.—243.0	1 white 30.0
	Yolk	14 med.—243.0	1 yolk 18.0
Fats and oils			
Butter		224.0	
Chicken fat	Rendered	220.0	
Compounds		200.0	
Cream	40% fat	236.0	
	18% fat	240.0	
Hydrogenated fats		200.0	
Lard		220.0	
Margarines		224.0	
Oils—Cottonseed		220.0	
corn		220.0	
peanut		220.0	
olive		220.0	
Suet	Rendered	220.0	
	Chopped—medium fine	120.0	

[1] Bureau of Home Economics, Washington, D. C., July 1937.

Food	Form or Kind	One Cup	Miscellaneous Measures
		Grams	
Flours and meals			1 t.
Banana flour	Sifted	118.0	
Barley flour	Sifted	80.0	
Buckwheat flour	Sifted	98.0	
Corn flour	Sifted	110.0	
Cornstarch	Stirred	128.0	3.0
Corn meal	Coarse, stirred	152.0	
	Fine, stirred	116.0	
Gluten flour	Sifted	142.0	
Lentil flour	Sifted	144.0	
Lima bean flour	Sifted	126.0	
Potato starch	Sifted	144.0	
Rice flour	Sifted	126.0	
Rice polish	Stirred	106.0	
Rye flour	Straight grade sifted	80.0	
Soybean flour	Sifted	86.0	
Wheat			
All-purpose	Sifted	110.0	
Hard (bread)	Sifted	112.0	
Soft (cake)	Sifted	96.0	
Soft (pastry)	Sifted	100.0	
Whole wheat	Stirred	120.0	
Wheat germ	Stirred	68.0	
Fruits—dried and preserved			
Apricots		150.0	
Citron	Diced	184.0	
Currants		144.0	
Dates—pitted	Whole	188.0	
	Cut	178.0	
Figs	Whole	178.0	
	Cut	168.0	
Ginger	Crystallized, diced	170.0	
Prunes	Whole with seeds No. 20–30	188.0	
	Whole with seeds No. 40–50	178.0	
	Whole with seeds No. 60–70	172.0	
Raisins	Seeded	142.0	
	Seedless	164.0	
Fruit juice			
Orange		248.0	
Lemon		246.0	

Food	Form or Kind	One Cup	Miscellaneous Measures
		Grams	
Gelatin	Granulated fine	138.0	
	Granulated coarse	148.0	
Leavening agents			
Baking powder			One teaspoon grams
SAS-phosphate K. C.	Unstirred		3.7
SAS-phosphate K. C.	Stirred		3.4
SAS-phosphate (Calumet)	Unstirred		4.1
SAS-phosphate (Calumet)	Stirred		3.8
Tartrate (Royal)	Unstirred		4.1
Tartrate (Royal)	Stirred		3.8
Phosphate (Rumford)	Unstirred		4.5
Phosphate (Rumford)	Stirred		4.3
Baking soda	Unstirred		4.5
Baking soda	Stirred		4.1
Cream of tartar	Unstirred		2.8
Cream of tartar	Stirred		2.6
Milk	Whole	244.0	
	Skimmed	246.0	
	Buttermilk	244.0	
	Condensed	306.0	
	Condensed with equal water	276.0	
	Evaporated (unsweetened)	252.0	
	Evaporated with equal water	244.0	
	Skim milk powder (spray dried sifted)	112.0	
Nuts			
Almonds	Shelled, whole	142.0	
	Blanched, whole	152.0	
	Blanched, chopped	130.0	
Coconut	Prepared, shredded	62.0	
Filberts	Shelled, whole	134.0	
Peanuts, medium	Halves	144.0	
	Chopped	144.0	
Pecans	Halves	108.0	
	Chopped	118.0	
Walnuts, Persian "English"	Halves	100.0	
	Chopped	122.0	
Walnuts, black	Broken	130.0	
	Chopped	126.0	

Food	Form or Kind	One Cup	Miscellaneous Measures
		Grams	
Pastes			
Macaroni	2-in. pieces—broken	86.0	
Noodles	2-in. pieces—broken	58.0	
Spaghetti	2-in. pieces—broken	94.0	
Tapioca	Pearl	164.0	
	Granulated, minute stirred	152.0	
Seasonings			One teaspoon grams
Salt	Free running, medium fine	288.0	6.0
Pepper			2.3
Sugars and syrups			
White	Granulated	200.0	
XX	Powdered	190.0	
XXXX—Confectioner's	Powdered, stirred	128.0	
Brown, light	Loose pack	150.0	
	Tight pack	228.0	
dark	Loose pack	138.0	
	Tight pack	212.0	
Syrups			
Corn		328.0	
Honey		338.0	
Maple		312.0	
Molasses	Cane	328.0	
Sorghum		330.0	
Tea	Orange Pekoe	72.0	
	Pinhead Gunpowder	104.0	
Vegetables—dried			
Beans			
Lima	Large	180.0	
	Small	186.0	
Navy	Large	184.0	
	Small	196.0	
Soybeans		210.0	
Peas	Split	200.0	

TEMPERATURE REGULATIONS AS RELATED TO COOKERY

Checking Oven Regulators

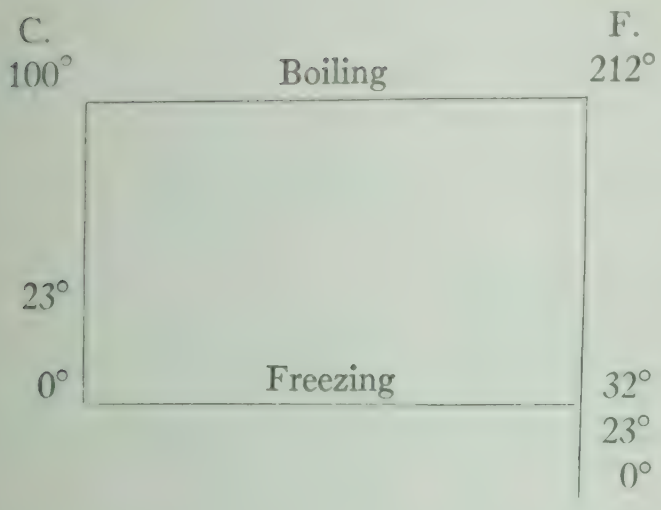
1. See that the thermometer is in good condition. Either check two against each other or use a standard thermometer.
2. Place thermometer (or thermometers) in the center of empty oven, equidistant from sides, top and bottom, front and back.
3. Light burners, and if within 15 to 20 minutes or longer the two thermometers agree and register a higher or lower temperature than that for which the regulator was set, the regulator is at fault.
4. Have local stove agent adjust the regulator.

Checking Thermometers

1. The thermometer should be held perpendicular and should not touch the cooking utensil when read. The eye should be on a level with the part of the scale being read. The bulb of the thermometer should be completely covered.
2. Place thermometer in hot water, bring to boiling point, and take reading after water has boiled about 1 minute.
3. Make corrections for altitude if necessary.
4. If the thermometer does not check within 2 degrees return to the manufacturer. If the variation is less than 2 degrees add or subtract the difference to the temperature given in a recipe.

Conversion of Fahrenheit to Centigrade and Centigrade to Fahrenheit Readings

On the Centigrade thermometer, 100 degrees cover the same space as 180 degrees on Fahrenheit, hence a Fahrenheit degree is smaller than a Centigrade degree. Thus, a change in temperature of 1 Centigrade degree is equal to a change in temperature of more than 1 degree Fahrenheit, that is, 9/5 of a degree Fahrenheit; and a change of 1 Fahrenheit degree is equal to a change of less than 1 degree Centigrade, or 5/9 of a degree. If it were not for the fact that the freezing point on the Fahrenheit is 32 degrees above the zero point it would be possible simply to multiply Fahrenheit degrees by 5/9 and Centigrade degrees by 9/5 and secure equivalent temperatures. However, since the freezing points are not similarly numbered, it is necessary to add or subtract 32 in making the change. This is further explained by the graphic illustration:



It is seen from this diagram that a temperature of 23°C. would be above freezing, while the same temperature Fahrenheit would be below the freezing point.

In order to change a Fahrenheit to a Centigrade reading or a Centigrade to a Fahrenheit reading use the following formulae:

C. reading = F.° —32°.5/9

F. reading = 9/5 C.° + 32°

TABLE OF EQUIVALENTS

1 gallon (gal.)	= 4 quarts (qt.)
1 quart	= 2 pints (pt.)
1 pint	= 2 cups (c.)
1 cup	= 16 tablespoons (tb.)
1 tablespoon	= 3 teaspoons (t.)
1 tablespoon	= ½ ounce (oz.) (Fluid)
1 teaspoon	= 60 drops
1 cup (standard)	= 236.5 cubic centimeters (cc.)
1 cup (standard)	= 8 ounces (oz.) = ½ pint
1 pound	= 453.6 grams (g.)
1 ounce	= 28.35 grams (g.)
1 kilogram (kg.)	= 1000 grams (g.)
1 kilogram	= 2.2 pounds (lbs.)
1 liter (l.)	= 1000 cubic centimeters (cc.)
1 liter	= 1.05 quarts (U. S. liquid)
1 liter	= 0.905 quart (U. S. dry)

Liquid Measure

8 fluid drams	1 fluid ounce
4 fluid ounces	1 gill
4 gills	1 pint
2 pints	1 quart (qt.)
4 quarts	1 gallon (dry)

Dry Measure

2 pints (pt.)	1 quart (qt.)
8 quarts	1 peck (pk.)
4 pecks	1 bushel (bu.)
105 quarts	1 barrel (bbl.)

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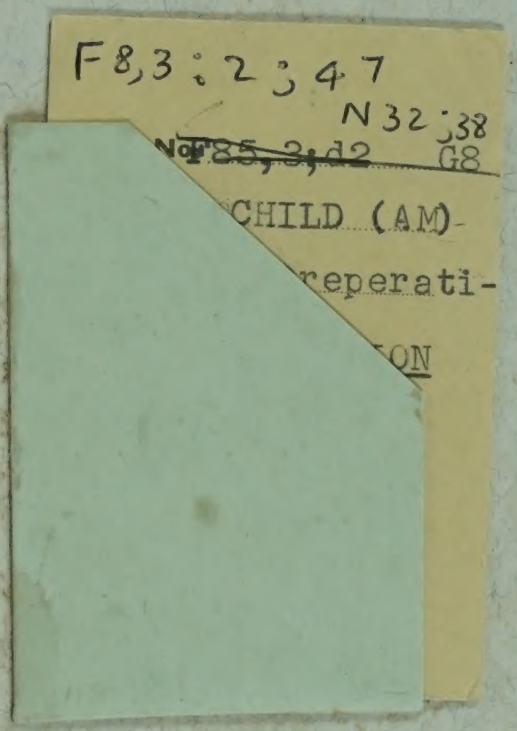
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